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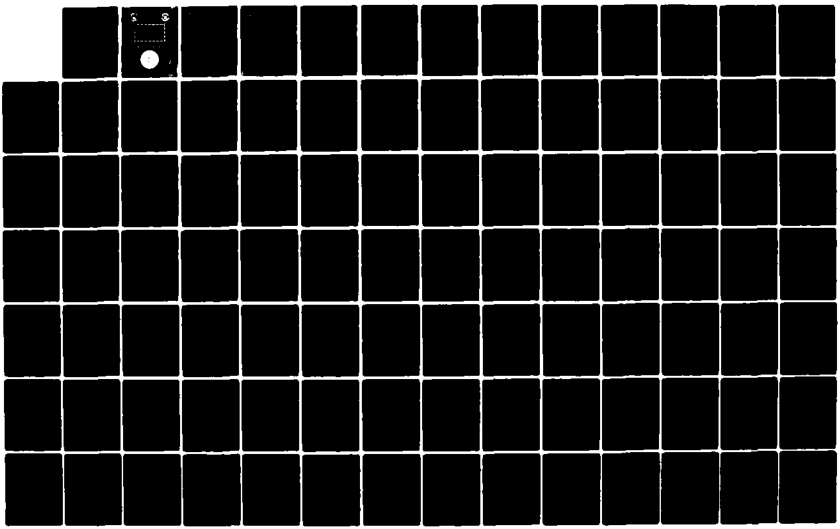

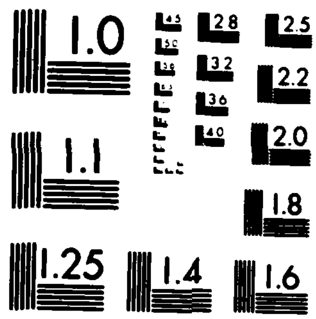
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DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

15 March 1983

ERRATUM

NEDU Report 1-83: Computer Algorithms Used in Computing the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Decompression Tables.

After publication and distribution, an error was found in Version 1.1 of Subroutine FRSP7 which will cause small underestimates in no-decompression time and which will (in certain instances) compute first stop depths one depth increment deeper than necessary. (The program computes 0 min stop times at these too deep first stops so the resulting decompression profiles are correct).

All holders of the above report should make the following changes and substitutions to the original:

1. Replace pages 40/41 and B4-1 thru B4-4 (Annex B4) with the attached pages. Note that the replacement pages are all coded ERR 1.0 in the lower right hand corner. Subroutine FRSP7 is now Version 1.2.

2. Make a pen and ink change to Fig. 9 (page 30). Change the no-decompression time at 110 FSW from 23 to 24 min.

All other decompression profiles and Model Parameter Printouts remain correct for Version 1.2 of Subroutine FRSP7.

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DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 1-83

COMPUTER ALGORITHMS USED IN COMPUTING THE MK 15/16 CONSTANT 0.7 ATA OXYGEN PARTIAL PRESSURE DECOMPRESSION TABLES

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JANUARY 1983

Approved for public release; distribution unlimited

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The computer algorithms used in computing the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Decompression Table are presented. These algorithms were used to compute both the nitrogen-oxygen and helium-oxygen tables. No physiological rationale or test results are presented. Two model independent input-output programs are presented which can be used with any decompression model which can be written in the prescribed 8 subroutines. One input-output program outputs each decompression schedule in a very detailed format while

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the other outputs schedules in U.S. Navy Decompression Table format. The 8 subroutines comprising the current MK 15/16 Decompression Model are presented in detail. Where changes in the Decompression Model were made, all versions of the appropriate subroutines are presented. All versions of the program used for computing ascent criteria are presented as well as tables of all ascent criteria actually used in the development of the current MK 15/16 Decompression Model. Annexes contain complete listings of all programs in the Fortran IV language.

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ABSTRACT

The computer algorithms used in computing the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Decompression Tables are presented. These algorithms were used to compute both the nitrogen-oxygen and helium-oxygen tables. No physiological rationale or test results are presented. Two model independent input-output programs are presented which can be used with any decompression model which can be written in the prescribed 8 subroutines. One input-output program outputs each decompression schedule in a very detailed format while the other outputs schedules in U.S. Navy Decompression Table format. The 8 subroutines comprising the current MK 15/16 Decompression Model are presented in detail. Where changes in the Decompression Model were made, all versions of the appropriate subroutines are presented. All versions of the program used for computing ascent criteria are presented as well as tables of all ascent criteria actually used in the development of the current MK 15/16 Decompression Model. Annexes contain complete listings of all programs in the Fortran IV language.

GLOSSARY

Algorithm	-	A sequence of logical steps used to obtain a mathematical result.
Decompression Profile	-	A table or graph showing the time/depth coordinates for an entire dive including all desired stops and all obligatory decompression stops.
Decompression Schedule	-	A listing showing required decompression stop depths and stop times for a particular Bottom Depth/Time dive.
Decompression Table	-	A structured set of decompression schedules usually organized in order of increasing Bottom Depths and Bottom Times.
Dive Profile	-	A table or graph of time/depth coordinates for an entire dive showing all desired stops without regard to decompression obligation.

INTRODUCTION

Over the period from 1977 through 1982, the U.S. Navy Experimental Diving Unit (NEDU) was tasked with developing a set of decompression procedures for use with the MK 15 and MK 16 Underwater Breathing Apparatus (UBA) using a constant oxygen partial pressure of 0.7 ATA and either helium or nitrogen as a diluent. A report regarding a portion of the development of schedules for use with nitrogen as the diluent has been published (1), and the results of schedule testing using helium as a diluent are forthcoming.

Previous efforts by the U.S. Navy in calculating decompression tables have generally started out with a decompression model of some sort but as development progressed, only schedules which produced decompression sickness were revised. Thus, the finished set of tables could not be completely calculated from the original assumptions because these revisions were not applied to all schedules. The effort resulting in the production of the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Tables differed in that a computer algorithm was first written and tested. As testing progressed, changes were made to the algorithm and only when a safe algorithm was found were a set of tables computed. Thus, all of the schedules contained in the tables were computed exactly the same way and can all be reproduced exactly from the programs described here. It must be realized, however, that roundoff errors could result in differences in stop times of up to 1 minute when different computer systems are used to run the algorithm. However, the total decompression time for a given schedule should never differ by more than 1 minute. These slight variations are considered insignificant.

The purpose of this report is to document the computer programs used in calculating the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Tables. No discussion of the physiological rationale behind the programs will be given at this time. Only the details necessary to understand the mathematical logic and to properly run the programs will be presented. In addition, complete listings of all programs and subroutines are presented.

All of the programs presented here are written in the Fortran IV language running under the Hewlett-Packard RTE IV-B Operating System. All subroutines which are peculiar to the RTE IV-B Operating System are identified for those wishing to bring up these programs using other operating systems. However, it must be understood that neither the authors nor NEDU have the time or facilities to assist in modification of these programs for use with other operating systems.

The RTE IV-B Operating System accepts only a single line of ASCII input for each Fortran READ Statement using the Free Field Format. The Free Field Format (FORMAT statement number specified as *) allows real or integer values, separated by commas, to be input on the same line and does not require a decimal point for whole real numbers. Once the return key is hit, all variables in the READ input list not specified on that line remain unchanged. Other operating systems may not handle Fortran READ Statements this way and program modifications may have to be made.

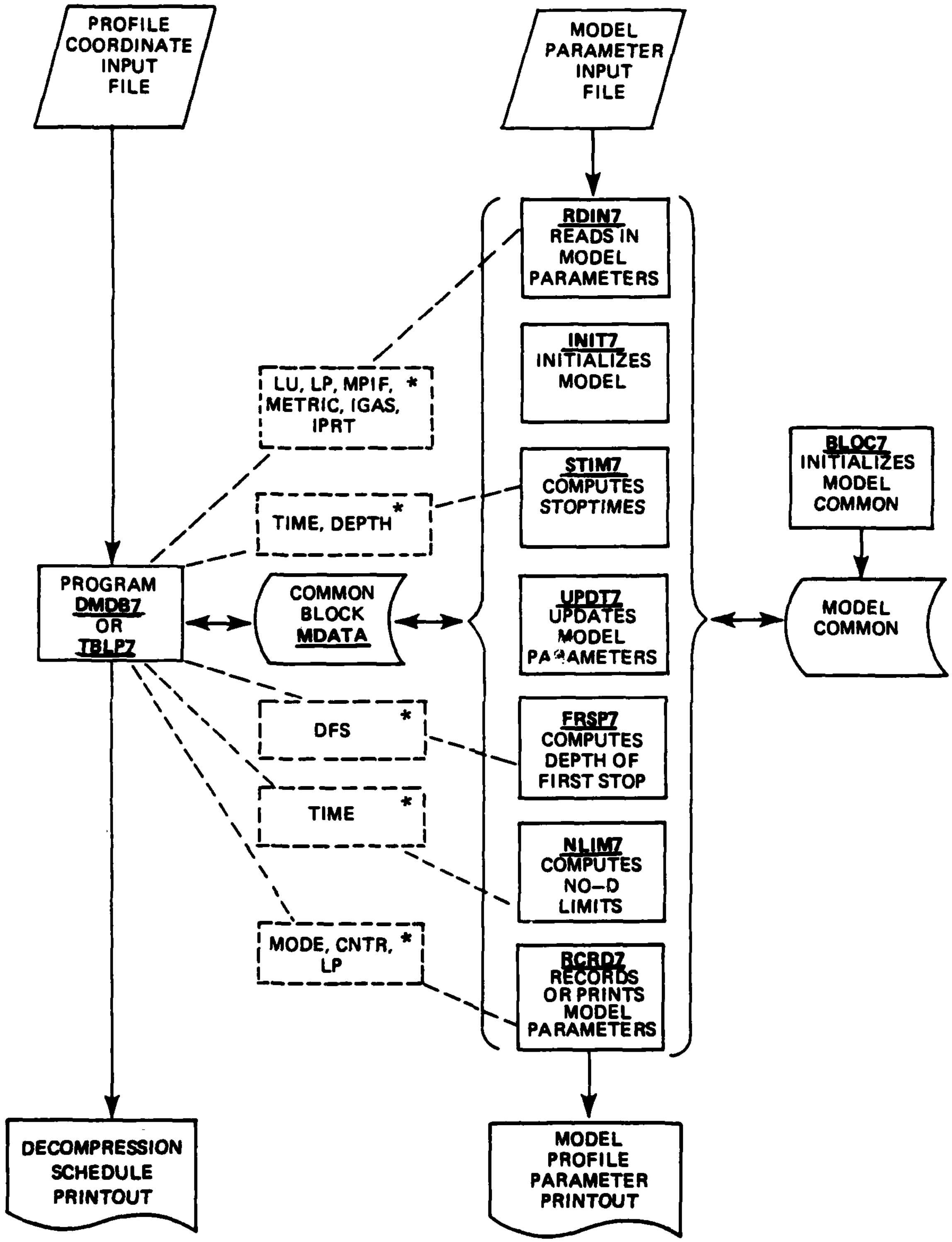
These programs are extremely flexible and can compute decompression schedules for a variety of dive profiles and breathing gases. However, it must be realized that only certain decompression schedules have been tested and shown to be safe. Some of the test results of these schedules have been published (1) and others will be the subject of future NEDU reports.

PROGRAM OVERVIEW

This report is divided into three parts. Part 1 describes the two model indpendent input-output programs DMDB7 and TBLP7 along with descriptions of associated input and output files. Part 2 describes the subroutines which comprise the MK 15/16 Decompression Model and Part 3 details the calculation of the various ascent criteria used with the Decompression Model.

The model independent input-output programs DMDB7 and TBLP7 are designed to accept time, depth and rate profile coordinates from a Profile Coordinate Input File and output a specific decompression schedule or a complete set of decompression tables in a specific format. These programs do no calculations related to the Decompression Model but pass parameters to the model and accept for output parameters such as stop depths and stop times which are computed by the model. The interactions of programs DMDB7 and TBLP7 with the decompression Model Subroutines is shown in Fig. 1. Although the MK 15/16 Decompression Model Subroutines used in the development of the computer algorithm are presented in Part 2 of this report, programs DMDB7 and TBLP7 are model independent and can be used with any decompression model so long as the conventions used to get data to and from the subroutines are adhered to. Both programs DMDB7 and TBLP7 accept the same types of inputs; they differ only in their outputs. Program DMDB7 outputs an exact decompression schedule with times computed to two decimal places and will also output Model Profile Parameters used during computation of the schedule. Program TBLP7 rounds off all decompression stops to whole minutes and outputs schedules in standard U.S. Navy Decompression Table format.

Detailed descriptions of each of the eight subroutines which comprise the MK 15/16 Decompression Model are presented in Part 2. During the development of the computer algorithm a change in the MK 15/16 Decompression Model was made. This change resulted in two versions of the Tissue Update Subroutine UPDT7 and the Stop Time Computation Subroutine STIM7. Version 1 is the most current version and assumes that tissues take up gas exponentially but form a gas phase after a certain amount of supersaturation at which point gas elimination proceeds linearly. This model will be referred to as the Exponential-Linear or E-L Model. Version 2 of these subroutines was the version used to compute the tables described in reference (1). It is the classical perfusion limited supersaturation model where no gas phase is ever assumed to form where both gas uptake and offgassing are assumed to be exponential. Version 2 will be referred to as the Exponential-Exponential or E-E Model.



* SEE PROGRAM LISTING FOR SYMBOL DEFINITIONS

FIGURE 1. INTERACTIONS BETWEEN MODEL INDEPENDENT INPUT-OUTPUT PROGRAMS AND DECOMPRESSION MODEL SUBROUTINES

PART 1

MODEL INDEPENDENT

INPUT-OUTPUT PROGRAMS

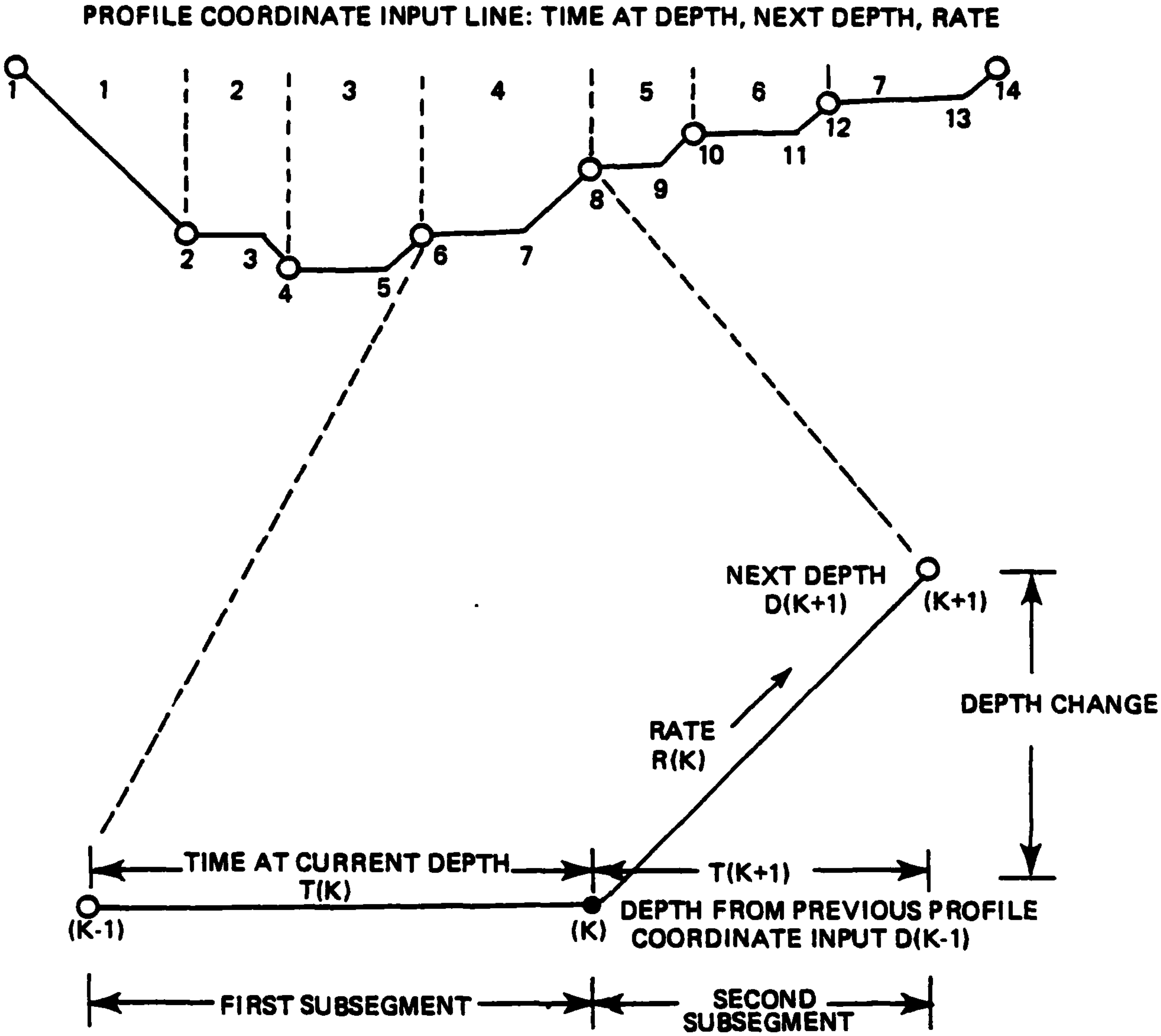
Introduction

Programs DMDB7 and TBLP7 (the I-O Programs) which are described in this section were designed to accommodate any decompression model which can be written as the 8 subroutines required by the I-O Programs. The I-O Programs accept input from a Profile Coordinate Input File which may be entered directly from a terminal. However, it is more convenient to create the Profile Coordinate Input File with a text editor and then have the program read in the file a line at a time from a mass storage device. In this way, errors in the input file are more easily corrected. The Profile Coordinate Input File describes the individual profile segments which make up the dive profile. The I-O Programs break these profile segments into two subsegments and pass the variables necessary to completely describe the subsegment to the Decompression Model in a common block. However, as seen in Fig. 1, subroutines RDIN7, STIM7, FRSP7, NLIM7 and RCRD7 also pass additional variables in their subroutine calling sequences. The Decompression Model performs whatever computation and record keeping it requires as each subsegment of the profile is processed. As long as descents are made the Decompression Model Subroutines provide little direction to program DMDB7 or TBLP7 but as soon as an ascent is desired these I-O Programs call on the Decompression Model Subroutines to provide them with the necessary stop depths and times in order to safely decompress to the next shallower depth. Once the ascent has been completed, programs DMDB7 and TBLP7 again take direction from the Profile Coordinate Input File until the next ascent is desired at which time the Decompression Model Subroutines take over. In simplistic terms the Profile Coordinate Input File directs descent while the Decompression Model Subroutines direct ascent. The only practical limit on the complexity of the dive profile are the sizes of the buffers which hold the decompression schedule as it is being calculated.

Since programs DMDB7 and TBLP7 both use the same input file structure, this will be described first.

Profile Coordinate Input File Format

Any dive profile no matter how complex can be broken down into segments. In Fig. 2 a dive profile consisting of seven segments is shown. All ascents and descents are assumed to be linear and each segment is assumed to be comprised of two subsegments; a stop for some time (which may be 0 min) at a constant depth followed by a linear ascent or descent to a new depth (the new depth and old depth may be the same resulting in no depth change). The profile in Fig. 2 only shows the depths and times of interest without regard to decompression obligation. It is up to the Model to provide information regarding any stops which must be taken during ascent. Thus, although all ascents shown in Fig. 2 show direct linear ascent to the next shallower depth the Decompression Model will compute and insert any required stops into each ascent subsegment. The specified ascent rate will be retained as the rate of ascent between decompression stops. Each profile segment is completely described by three parameters; the TIME at the current depth, the Next DEPTH, and the RATE of depth change. Programs DMDB7 and TBLP7 require the RATE to always be a non-zero number, even if no depth change will occur.



DIVE PROFILE MATRIX (Time, Depth, Rate)

	T	D	R
K-1			
K	TIME AT DEPTH		RATE
K+1	$\frac{D(K+1)-D(K)}{\text{RATE}}$	NEXT DEPTH	0.0
K+2		NEXT DEPTH	

FIGURE 2. TYPICAL DIVE PROFILE SHOWING A PROFILE SEGMENT AND DETAILS OF EACH OF THE TWO SUBSEGMENTS

Each time a profile coordinate input is expected, the Profile Matrix Pointer (K) points to the junction of the first and second subsegment. After the profile coordinates are input, the I-O Program executes two model updates, one for each subsegment. The Time at the Current Depth specifies the number of minutes to be spent at the Depth which was input in the previous Profile Coordinate Input Line [D(K-1)]. The Next Depth and Rate specify where the profile goes to next and what the desired rate of depth change is. The Depth Change and time required for the change, T(K+1), are computed by the I-O Programs. The I-O Programs enter the profile coordinates into the Dive Profile Matrix as shown in Fig. 2. Time at the Current Depth is T(K), the Next Depth is D(K+1) and the Rate is R(K). The I-O Program computes T(K+1) and enters a value of 0.0 at R(K+1). The value at the next Depth is also entered again as D(K+2). If the Model determines that stops are required D(K+1) and D(K+2) will be the depths of the first stops as computed by the Decompression Model. After all updates are completed K is incremented by 2 and will point to the K+2 position in the portion of the Dive Profile Matrix shown in Fig. 2. The final entry in any Dive Profile Matrix is made at K+1, and printout will stop at the K+1 position of the final profile segment.

The Profile Coordinate Input File contains the Time at Current Depth, Next Depth, and Rate coordinates which describe the dive profile as well as other information needed to compute the decompression schedule. An example of an input file is shown in Fig. 3. The line numbers on the left are for reference and are not part of the file. This particular file contains five separate profile descriptions. The first two lines of the file, the name of the Model Input Parameter File followed by the Units and Depth Increment are specified only once in the input file no matter how many profiles are described in the file. The Model Input Parameter Filename is passed to Subroutine RDIN7 which reads the file and passes the data to the other Decompression Model Subroutines. The first integer in the second line of the input file specifies the depth units which will be used for input. A value of "1" means all depth and rate inputs will be in feet and any other value means all depth and rate inputs will be in meters. The I-O Program passes a conversion factor to convert meters to feet to the Decompression Model Subroutines which use depth units of feet internally for the most part. The next integer is the Depth Increment and is usually one of three values; 10, 5, or 3. A value of "10" is usually used with input units in feet and signifies that all stops will be in 10 feet of seawater (FSW) increments. When meters are used for input, the Depth Increment is usually "3" or "5" signifying 3 or 5 meters of seawater (MSW) stop depth increments. Other depth increments may be used but they must be whole numbers.

Lines 3 through 12 of the input file shown in Fig. 3 represent the profile coordinate inputs for the first profile. The last line of input for the profile (which in this case is line 12) is "YES" signifying that another profile follows. If the last line of input had been "NO", as in line 56, then the program would stop. As long as the last input for each profile is "YES", additional profiles may be input. There is no limit to the number of profiles which may be described. After the last profile has been input, this last line must be "NO", as it is for the last line of the 5th profile.

```
NAVTS1 T=00004 IS ON CR00012 USING 00003 BLKS R=0000

0001  HVAL09      ------- MODEL INPUT PARAMETER FILE NAME
0002  1,10        ------- UNITS, DEPTH INCREMENT
0003  150/ND      ------ PROFILE IDENTIFIER
0004  .79,1.0     ------ GAS TENSION
0005  0,0,60      ------ INITIALIZATION DEPTH, NEXT DEPTH, RATE
0006  F1          ------ OPTIONS
0007  0,150,60    ------ TIME, NEXT DEPTH, RATE
0008  P1          ------ OPTIONS
0009  0,0,60      ----- TIME, NEXT DEPTH, RATE
0010  P1NDFN      ----- OPTIONS
0011  YES         ----- PRINTOUT MODEL PROFILE PARAMETERS?
0012  YES         ---- ANOTHER PROFILE TO FOLLOW?
0013  150/30
0014  .79,1.0
0015  0,0,60
0016  F1
0017  0,150,60      2ND PROFILE
0018  P1
0019  30,0,60
0020  P1TXFN
0021  YES
0022  YES
0023  150/30
0024  .79,1.0
0025  0,0,60
0026  F1
0027  0,150,60      3RD PROFILE
0028  P1
0029  30,0,60
0030  P1DXTXFN
0031  YES
0032  YES
0033  150/30
0034  .79,1.0
0035  0,0,60
0036  F1
0037  0,150,60      4TH PROFILE
0038  P1
0039  30,20,60
0040  P1LSTXFN
0041  YES
0042  YES
0043  150/30
0044  .79,1.0
0045  0,0,60
0046  F1
0047  0,150,60
0048  P1
0049  30,20,60      5TH PROFILE
0050  P1TX
0051  0,20,60
0052  F1
0053  2,0,60
0054  F1FN
0055  YES
0056  NO
```

FIGURE 3. PROFILE COORDINATE INPUT FILE FORMAT. THE LINE NUMBERS TO THE LEFT ARE FOR REFERENCE AND ARE NOT PART OF THE FILE.

The third line of input is the Profile Identifier, and the fourth line of input contains up to eight gas tension values, (only 2 are shown) each separated by a comma. The first, third, fifth and seventh values are interpreted as inert gas fractions, (First Inert Gas Fraction, Second Inert Gas Fraction, etc.) the second, fourth, sixth and eighth as oxygen partial pressures in atmospheres absolute (ATA)(First Oxygen Partial Pressure, Second Oxygen Partial Pressure, etc.). It is not necessary to input all eight values. For example, in air dives only one value need be entered, a First Inert Gas Fraction Value of 0.79. In the profile shown in Fig. 3, only two values are used; an inert gas fraction of 0.79 and an oxygen partial pressure of 1.0 ATA. Options which will be described below specify which of these gas tensions is used by the Decompression Model for a profile segment particular update.

After the gas tensions have been entered, the next lines of input occur in pairs. The first line of each pair is a line of profile coordinates for a single profile segment as shown in Fig. 2, and the next line of each pair contains up to 8 characters which specify the four options (Table 1). These options describe various conditions which will be present over the entire segment. The first option (an alphanumeric character followed by an integer) is always used to specify what gas tension should be used for an update. The next three options (pairs of alphnumeric characters) are used to modify the profile computation procedure. These pairs of input lines (Profile Coordinates, Options) are repeated until all segments of the dive profile have been entered. In the first profile of Fig. 3, three pairs of lines (line numbers 5, 6; 7, 8; 9, 10) are needed to describe the profile. The option line of the last pair of lines must contain an "FN" as one of the three options, signifying that no further profile coordinates will be entered for this particular profile (line 10, Fig. 3). The next line of input (line 11, Fig. 3) specifies whether or not a printout of the Model Profile Parameters by Subroutine RCRD7 is desired ("YES" or "NO"). Finally, the last line of input for a given profile (line 12, Fig. 2) specifies whether or not another profile will follow. If "YES" is input then a new profile may be described starting with the Profile Identifier. If "NO" is input then the program stops. Note that the formats for the numerical inputs in Fig. 3 are somewhat arbitrary since all of these are read by the RTE IV-B Operating System in free field format; that is no decimal point need be specified for real numbers as long as the inputs are separated by commas. The only constraints on input are that times and depths must be whole numbers and alphanumeric inputs must be formatted as shown without intervening commas. Rates may be less than 1.0 only for Program DMDB7 but must be entered as non-zero values even if there is no depth change. The program will assign the proper sign to the rate.

As mentioned earlier, each Time, Next Depth, Rate input line describes a profile segment as shown in Fig. 2. However, the first Profile Coordinate Line entered for any profile (e.g. the 5th input line in Fig. 3) is unique in that the first value is the Initialization Depth rather than the Time at Current Depth. The Decompression Model will be initialized at the Initialization Depth and the first depth in the dive profile matrix (D(1) Fig. 2)

TABLE 1.

LEGAL OPTION INPUTS

First Option

First Character

P	Specifies Oxygen Partial Pressure to be used for Model Update.
F	Specifies Inert Gas Fraction to be used for Model Update.

Second Character

1,2,3, or 4	Specifies which Partial Pressure or Inter Gas Fraction is to be used.

Second, Third and/or Fourth Option

ND	Compute no-decompression time and substitute its value for the Time at Depth.
FN	This is the last line of input for this profile.
DX	Do not compute decompression stops for ascents, ascend directly to the Next Depth without stopping.
TX	Time at Current Depth includes descent time. Subtract descent time from previous depth from Time at Current Depth input.
LS	Next Depth is the last depth before surfacing. Compute a stop time at Next Depth which will allow ascent directly to the surface.

NOTE: The second character of the First Option must be a number. If it is not, an error will result. Option Inputs other than those above (or no input) will result in options ND, FN, DX and LS not being executed. The inert gas tension in use will remain as specified the last time a legal gas tension was specified.

will be set to that depth. T(1) will always be 0.0 and R(1) will be set to the specified rate. The program will compute T(2) and enter the Next Depth into D(2) and D(3) and set R(2) to 0.0. The pointer K will then be set to 3 so it is in position for the next profile segment input.

Whenever an ascent is specified a check is made to see if decompression stops are needed. If they are, the Decompression Model Subroutines will be called on to compute the values for Time at Depth and Next Depth for each subsequent profile segment until the Next Depth specified in the Profile Coordinate Line is reached at which point input from the Profile Coordinate Input File will again be accepted. However, by specifying "DX" as an option this feature will be disabled over the segment specified by the preceeding Profile Coordinate Input Line and ascent will proceed directly to the specified Next Depth without any decompression stops. This option is usually used to analyze profiles generated by other decompression models.

The Dive Profile Matrix in Programs DMDB7 and TBLP7 can hold a maximum of 100 points or 50 profile segments. Each descent will specify only one profile segment but each ascent may require several profile segments depending on the number of decompression stops required. This must be kept in mind so that the Dive Profile Matrix does not overflow during a final ascent from some depth to the surface.

Legal options which may be specified in the Option Line have been given in Table 1. Options which specify gas tensions are only allowed as the First Option and are put into effect before any model updates are performed on a given profile segment. If one of the legal First Options as shown in Table 1 is not specified, the gas tension specified the last time a legal First Option was input will be used for model updates. The last three options do not have to be specified if none of these options are needed, as they are all disabled just before the Option Line is read.

As mentioned before, zero Time at Depth and zero Depth Changes are legal and some of the uses of these inputs will now be discussed. A zero Time at Depth is usually input if "ND" is specified as an option because entering "ND" will cause the no-decompression time at the previously input DEPTH to be computed and used in lieu of the time actually entered (line 9,10; Fig. 3).

Another use for a zero Time at Depth input is to change breathing gases during ascent or descent. In the 5th profile of Fig. 3, a constant oxygen partial pressure of 1.0 ATA is used to begin ascent to 20 FSW at 60 FPM after spending 30 min at 150 FSW (line 49 and 50, Fig. 3). In line 51 the Time at Depth input is "0" and the Depth input "20" but the option "F1" in line 52 causes a switch to be made from the First Oxygen Partial Pressure to the First Inert Gas Fraction before beginning the model update for that profile segment. In line 53, even though a Time at Depth of 0 min was specified, the program will call on the Decompression Model Subroutines to see if a 20 FSW stop is necessary before ascending to the next depth, and the appropriate stop time will be computed.

Similarly, a zero Depth Change can be used to specify a gas change at a particular depth while stopped at that depth. Notice the first two pairs of Profile Coordinate/Option Lines in all of the profiles in Fig. 2 (lines 5, 6; 15, 16; 25, 26; 35, 36; 45, 46). The first line of each pair causes the profile to be initialized at 0 FSW using the First Inert Gas Fraction specified in the following Option Line of each pair. After initialization the depth remains at 0 FSW, that is no depth change is made. In each entry following the above pairs of lines, a time of 0 min is specified followed by DEPTH and RATE. This will cause a 0 min stop at 0 FSW but will switch to the First Oxygen Partial Pressure (P1) before beginning descent (lines 7, 8; 17, 18; 27, 28; 37, 38; 47, 48 in Fig. 3).

The only way to terminate a profile is to specify "FN" as one of the options after the last Profile Coordinate Input Line. At this point, the decompression schedule computation is terminated after the specified depth in the last Profile Coordinate Input Line is reached.

If the "LS" option is specified, then the profile will ascend to the specified Next Depth taking any necessary decompression stops and a stop time will be computed at Next Depth such that ascent can be made directly to the surface from that depth. If the specified Next Depth is so deep that ascent to the surface is not possible a stop time of 9999 minutes will be computed. After stopping at Next Depth for the computed stop time, the program will then proceed to the surface, update the model and stop. Specifying "LS" as an option is useful in constructing decompression schedules such as are found in the U.S. Navy Surface Supplied Helium Oxygen Tables where the last stop is at 40 FSW after a switch to 100% oxygen has been made at 50 FSW. The fourth profile in Fig. 3 specifies a total bottom time of 30 min at 150 FSW before ascending to 20 FSW at 60 FPM (line 39, Fig. 3). In line 40, the "LS" option is specified. Any decompression stops between 150 FSW and 20 FSW will be computed automatically. Since the "LS" option was specified, a stop time will be computed at 20 FSW such that ascent can be made directly to 0 FSW. The appropriate stop will be taken, the model will be updated to 0 FSW and decompression schedule computation will then be terminated because the "FN" option was also specified in line 40.

The "TX" option is useful for specifying bottom times rather than actual time at depth. If this option is not specified then the program will assume that the TIME input from the Profile Coordinate Line represents the actual number of minutes to be spent at the current depth. However, if the "TX" option is specified, the program will interpret this time as Total Bottom Time (sum of descent time and actual time at depth) and subtract the descent time from the previous depth from the specified Time at Current Depth to get the actual time at depth which is then passed to the Decompression Model. All of the profiles described in Fig. 3 specify the "TX" option for descent to 150 FSW (lines 20, 30, 40, 50) so that the actual time at 150 FSW will be 27.5 min (30 min bottom time minus 2.5 min descent time). If the "TX" option had not been specified, the times in lines 19, 29, 39 and 49 would have had to be 27.5 min instead of 30 min to describe the same profile.

Program DMDB7

This program accepts input from a Profile Coordinate Input File and outputs a detailed decompression profile. All times are computed to two decimal places and the program can cause the model to output values of all model variables at each stop so a detailed picture of exactly how the decompression profile was computed is obtained.

Program DMDB7 is model independent and can be used with any decompression model which can be written as the prescribed subroutines. All profile coordinate data is passed to the subroutines in the Common Block MDATA. This Common Statement describing the Common Block MDATA must appear in all Decompression Model Subroutines and the subroutines should change the values of the MDATA variables only after ensuring no undesirable side effects will occur. Some subroutines (RDIN7, RCRD7, STIM7, FRSP7, and NLIM7) carry variables with them which do not appear in MDATA.

Program DMDB7 contains 6 procedures; Program Initialization, Profile Initialization, Profile Generation and Update Loop, First Stop Depth Computation, Stop Time Computation, and Profile Output. Program Initialization is carried out only once each time the program is run. It reads the first two lines of the Profile Coordinate Input File and has the Decompression Model Subroutines get all the parameters which will be used to compute the decompresion schedules. The same Model Input Parameter File, Depth Units and Depth Increment will then be used for all profiles described by the Profile Coordinate Input File.

The Profile Initialization Procedure is executed once for each profile described in the Profile Coordinate Input File. It reads in the Profile Identifier Label and the Gas Tensions which will be used for each particular dive profile. Variables and counters specific to each profile are then initialized.

The Profile Generation and Update Loop reads in the Profile Coordinate and Option Line pairs describing each profile segment and instructs the Decompression Model to update its parameters for the two subsegments which comprise each segment. The First Stop Depth and Stop Time Procedures are called from this loop to compute decompression stops each time an ascent is specified. This loop also calls on a subroutine to record all the coordinates which will then describe the decompression profile.

The First Stop Depth Computation Procedure is used to find the depth of the first stop every time an ascent is specified. It should be noted that there will always be a stop at one stop depth increment below the surface even if the stop time is zero as it will be in no-decompression dives. If decompression stops are required during ascent, this procedure sets a flag which causes input from the Profile Coordinate Input File to be temporarily suspended and for the Profile Generation and Update Loop to cause ascent in increments of one Stop Depth Increment calling upon the Stop Time Computation Procedure to compute the time to be spent at each stop.

The Profile Output Procedure outputs the Decompression Profile on one page of the line printer and then prints out the Decompression Model Parameters on the next page if they are desired.

A complete listing of Program DMDB7 is given in Appendix A-1. All references to line numbers will refer to the line numbers in the first column of the listing. Fortran statement numbers in the program will be referred to as Statement Numbers.

Program Initialization Procedure (Lines 150 - 191)

First the date and time are read from the RTE IV-B Operating System for use in printout headers. Then the RTE IV-B Operating System establishes the device number of the terminal being used to control the program. Next (line 165), the name of the Model Parameter Input File is read from Profile Coordinate Input File device LB (which is in our case is a 9 track magnetic tape) and printed out on the terminal. Then the desired Units and Depth Increment are read in and written on the terminal. In lines 171 and 172 the logical variable METRIC is set to "true" if all inputs are to be in meters and "false" if all inputs are to be in feet. If metric input is expected the correction factor CF is set to 1/.3048 which will convert all depth inputs from meters to feet, otherwise CF is set to 1. Finally (line 186), a message is printed on the terminal asking the user if he wants to have the model parameters printed out. The response to this question is the value of the variable IPRT which is passed to Subroutine RDIN7. The other variables passed to this subroutine are the device number of the terminal being used (LU), the device number of the line printer (LP), the name of the Model Parameter Input Filename (MPIF), and the value of the logical variable METRIC. Subroutine RDIN7 also uses the value of the Depth Increment (DINC) and the correction factor (CF) but these are passed to the subroutine in the Common Block MDATA. Subroutine RDIN7 returns the names of the breathing gas(es) contained in the Model Parameter Input File in the array IGAS.

Profile Initialization Procedure (Lines 204 - 228)

The Profile Identifier is read from the Profile Coordinate Input File then the inert gas fractions and tensions are read. One to eight values may be input here but gas fractions must be the first, third, fifth, and seventh values and oxygen partial pressures in ATA the second, fourth, sixth and eighth. The logical variables which determine if a first stop is to be calculated (CFSTOP) or if stop times need to be calculated (CSTIME) are initially set to "false". The model parameter counter used by Subroutine RCRD7 (CNTR) and the profile matrices pointer (K) are both set to 1. Finally, the depth at which the Model will be initialized, the next desired depth and the rate are read into CDEPTH, DEPTH and RATE respectively. TIME is set at 0.0 signifying that after initilization at CDEPTH no time is spent there before proceeding to DEPTH. After this line of input is read control

is transferred past the subsequent profile coordinate input statement to Statement 211 (line 250). It should be noted that the Program Initialization Procedure is performed only once for a given Profile Coordinate Input File. Each additional dive profile will cause the program to reenter at Statement 200 (line 207), the start of the Profile Initialization Procedure.

Profile Generation and Update Loop (Lines 243 - 365)

This is the meat of Program DMDB7. Statement 210 reads in the time to be spent at the current depth (TIME), the next depth in the profile (DEPTH) and the rate of the depth change (RATE). Note that the coordinates for the start of the profile were input in the Profile Initialization Procedure so Statement 210 is skipped the first time the Profile Generation and Update Loop is entered. All subsequent profile coordinate inputs from the Profile Coordinate Input File are read in by Statement 210. Also, note that the current depth (CDEPTH) was initially set by the Profile Initialization Procedure and will not be updated until the end of the Profile Generation and Update Loop. Next (line 250), the rate is given the proper sign and the four options are read into array OPTN (line 255). Notice the number specified as the second character in the Gas Tension Option is read into the integer variable NGAS. The five logical variables whose value is specified by the five legal second through fourth options are initially set to "false". Next (line 265), if the first character of the first option was not a "F" or a "P" (the only two legal inputs) all option decoding will be skipped. In lines 269 and 270 the logical variable CPO2 will be set to "true" if a constant oxygen partial pressure was specified and to "false" if a constant inert gas fraction was specified. The proper values are then assigned to FN_2 and PO_2 from the array GASTSN depending on the value of CPO2 and NGAS (line 271, 272). The remaining three options are now decoded and the appropriate logical variables set to "true" for specified options (line 276 -282). The DO Loop configuration allows these three optons to occur in any sequence in the option line.

When the Profile Generation and Update Loop is entered for the first time from the Profile Initialization Procedure, the counter K is equal to "1" signifying the beginning of the profile. In this case the Decompression Model Subroutine INIT7 is called at line 286 and the Decompression Model is initialized at CDEPTH (which is usually 0) using the oxygen tension specified in the option line. Next at line 293 the variable CFSTOP is set to "true" if an ascent is to take place (and the automatic decompression feature has not been overridden by specifying the "DX" option). By setting CFSTOP to "true" a first stop depth will be calculated later on to see if decompression stops during the ascent will be necessary. If the "TX" option was specified, then BTMTIM was set to "true" in line 278 and the previous time increment is subtracted from TIME in line 298. The value of TIME will never be allowed to be less than 0.0 as it could be if the bottom time were inadvertently specified as a value less than the descent time. Normally the value of TIME is the actual amount of time to be spent at the current depth before proceeding to the next depth. By specifying the "TX" option, one is saying

that the value of TIME includes the descent time from the previous depth and this descent time must be subtracted from TIME so the actual time at depth can be used to update the Model. In cases where a no-decompression dive is to be done, TIME is usually entered as "0" and the "ND" option is specified causing NODLIM to be set to "true" in line 279. When NODLIM is "true", subroutine NLIM7 is called to compute the no-decompression time at the current depth and this value is assigned to the variable TIME (line 302).

In lines 307 through 321 the profile coordinate values for the current depth, time, rate, gas tension, and the appropriate gas tension label are assigned to the D, T, R, GAS and GASLBL profile coordinate arrays, the Model Parameters are updated for the first subsegment by Subroutine UPDT7 and then recorded by Subroutine RCRD7 for future output. The pointer to the current position in the profile coordinate arrays is K and it points to the position in the profile segment as shown in Fig 2. Each time the Profile Generation and Update Loop is executed, two array entries are made, one at position K and the other at position K+1. The five entries at position K are made first (lines 307 -313) then the variables RATE, DC and TC are assigned the values needed to update the Model over the first subsegment (lines 317-319). The RATE and depth change (DC) are always 0 because no depth change occurs in the first subsegment, the depth entry at position K and K-1 both being the current depth CDEPTH. Thus, when the Model Update Subroutine UPDT7 is called it updates the Model for a stop of TIME minutes at the current depth CDEPTH. After the Model is updated Subroutine RCRD7 is called to record the Model Parameters for later printout (line 321). The first argument in RCRD7 is the mode, a "0" signifies recording a "1" signifies a printout. The next argument in Subroutine RCRD7 is the counter (CNTR) to keep track of how many records have been recorded. The subroutine automatically increments CNTR by "1" each time it is called so CNTR need not be incremented in the main program. Once initialized to "1" Program DMDB7 no longer changes the value of CNTR. Finally the device number of the line printer (LP) is passed to the subroutine and is used if a printout is desired.

In line 329 value of RATE is updated for the second profile subsegment. In this subsegment, a depth change DC occurs (which may be "0") and the rate of travel between them is given by RATE. If CFSTOP is "true" (which occurs for all ascents) then the program branches to the First Stop Depth Computation Procedure.

First Stop Depth Computation Procedure (Lines 383 - 406)

Subroutine FRSP7 returns the depth of the first stop (DFS). If the depth of the first stop is shallower than the next depth no stops are needed and ascent can be made directly to the next depth. However, if the next depth is "0" a First Stop Depth of DINC will always be specified. If stops are required, the value of the next depth currently stored in DEPTH is temporarily stored in FDEPTH and DEPTH is assigned the value of DFS or DINC, whichever is greater (line 398) . The logical variable CSTIME is set to "true" so stop times will be computed after the first stop depth is reached.

Whether a stop is needed or not CFSTOP is set to "false" so the First Stop Procedure will not be executed again unless there is another ascent input from the Profile Coordinate Input File.

Profile Generation and Update Loop (Continued)
(Lines 334 - 364)

Having established what the next depth is to be, the depth change (DC) and the time change (TC) to the next depth are calculated (lines 334, 335). Subroutine UPDT7 updates the Model over the second subsegment and Subroutine RCRD7 records the parameters. Next the depth, time increment, rate, gas tension, and gas tension label are recorded in the K+1 position of the profile arrays (lines 341-345). Note that the rate recorded here is "0" because the first half of the next subsegment will have no depth change. Finally, the current depth (CDEPTH) is updated to DEPTH and the counter (K) incremented by "2" to get the pointer in position for the next profile subsegment. At this point (line 358), control is transferred to one of two places. If stop times are needed (CSTIME or LSTOP "true"), then control is transferred to the Stop Time Computation Procedure. This procedure computes the time which has to be spent at the current depth before being able to ascend a maximum of one depth increment shallower. All previously specified options for gas tensions remain in effect while stop times are being computed. The Stop Time Computation Procedure continues to be called to compute stop times and decrement the depth until the next depth (FDEPTH) is reached. At this point control will be transferred back to Statement 210 (line 246) and the next set of profile coordinates accepted. If no stop times are needed, then control is passed directly back to Statement 210 if DONE is "false". If it is "true" then the last set of profile coordinates as been entered and control is transferred to the Profile Output Procedure beginning at Statement 500 (line 484).

Stop Time Computation Procedure
(Lines 428 - 468)

In line 431 a check is made to see if the current depth is within one depth increment of the final depth. If it is not then the DEPTH is set equal to one depth increment (DINC) less than the current depth (CDEPTH) and the stop time at the current depth necessary to allow ascent from CDEPTH to DEPTH is calculated. Control is then transferred back to Statement 220 (line 307) at line 440. The Subroutine STIM7 has two arguments. TIME returns the stop time and the second argument is the depth to which ascent is desired after a stop of TIME minutes at the current depth. If the current depth is within one depth increment of the final depth, control is passed to Statement 410 (line 444). If CSTIME is "true" it means that the final depth (FDEPTH) has not yet been reached. This is necessitated by the fact that control is passed to the Stop Time Computation Procedure at line 358 if either CSTIME or LSTOP is true. Initially, both variables may be true since the "LS" option which sets LSTOP "true" must occur during an ascent which will always set CSTIME to "true". When control is transferred to Statement 410 for the first

time, CSTIME has to be "true" because it is only set to "false" at line 466 which can be gotten to only via Statement 410. So the first time control passes to Statement 410 it will transfer control to Statement 420 (line 461) where the stop time before ascending to the final depth (FDEPTH) is computed. CSTIME is set to "false" before returning to Statement 220. Once CSTIME has been set to "false" at line 466, the only condition at line 358 which will cause control to be again transferred to the Stop Time Computation Procedure is if LSTOP is "true". If it is, then control is passed from Statement 400 to Statement 410 and down to line 452 because CSTIME was set to "false" on the previous pass through the procedure. FDEPTH is set to "0.0" at line 452 because one wants to ascend directly to "0.0" after staying at CDEPTH for the appropriate time. The stop time is computed and CSTIME is set to "true" once more so stop times at each stop depth increment during ascent from CDEPTH to the surface will be recorded. The stop times at these depths should be "0.0" and the real purpose of having each stop time computed is to cause the model parameters to be recorded at each stop depth increment as ascent to the surface occurs. LSTOP is set to "false" in line 456 so once the surface is reached, no further stop times will be computed and control will be transferred back to Statement 220 (line 307).

Once LSTOP and CSTIME are both "false", the program remains in the Profile Generation and Update Loop until DONE is set to "true". As will be recalled, this occurs only after "FN" has been specified as an option. If DONE is "true", control passes to the Profile Output Procedure which begins at Statement 500 (line 484).

Profile Output Procedure
(Line 481 - 537)

Once the current profile input has been finished, the zero times (ZT) of each profile subsegment are computed by serially summing time increments (T) (lines 484-486). Then the Profile Coordinate Input File is read to see if a model parameter output in addition to the profile output is desired (line 490). A header is written out on the first page of output (line 494-503) followed by the dive profile zero time (ZT), elapsed time (T), depth (D), rate (R), gas tension (GAS), and gas tension label (GASLBL) arrays (line 507, 508). Note that the last recorded entry is at the K-1 position in these arrays. If a model parameter printout is desired, a header is written on a second page (line 516-524) and Subroutine RCRD7 is called with the mode set to "1", signifying that a printout is desired (line 528). Lastly, the Profile Coordinate Input File is read again to see if another profile follows (line 533). If MORE is not "YE(S)", the program stops; if it is then control goes back to the Profile Initialization Procedure beginning at Statement 200 (line 207).

Profile Output from Program DMDB7

Figures 4 and 5 show the 5 Profile Printouts generated by the Profile Coordinate Input File in Fig. 3. It must be emphasized that the decompression profiles shown here are examples only and do not necessarily

PROFILE 1

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/ND
```

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
14.05	11.55	150	-60	1.00 ATA
16.39	2.33	10	0	1.00 ATA
16.39	0.00	10	-60	1.00 ATA
16.55	.17	0	0	1.00 ATA

PROFILE 2

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
30.00	27.50	150	-60	1.00 ATA
32.00	2.00	30	0	1.00 ATA
35.06	3.06	30	-60	1.00 ATA
35.22	.17	20	0	1.00 ATA
41.45	6.23	20	-60	1.00 ATA
41.62	.17	10	0	1.00 ATA
52.92	11.30	10	-60	1.00 ATA
53.08	.17	0	0	1.00 ATA

PROFILE 3

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
30.00	27.50	150	-60	1.00 ATA
32.50	2.50	0	0	1.00 ATA

FIGURE 4. PROFILE OUTPUTS AS PRINTED BY PROGRAM DMDB7 FOR THE FIRST THREE PROFILES IN THE FILE SHOWN IN FIGURE 3.

PROFILE 4

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
30.00	27.50	150	-60	1.00 ATA
32.00	2.00	30	0	1.00 ATA
35.06	3.06	30	-60	1.00 ATA
35.22	.17	20	0	1.00 ATA
52.75	17.53	20	-60	1.00 ATA
52.92	.17	10	0	1.00 ATA
52.92	0.00	10	-60	1.00 ATA
53.08	.17	0	0	1.00 ATA

PROFILE 5

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
30.00	27.50	150	-60	1.00 ATA
32.00	2.00	30	0	1.00 ATA
35.06	3.06	30	-60	1.00 ATA
35.22	.17	20	0	1.00 ATA
35.22	0.00	20	60	79.00 %
35.22	0.00	20	0	79.00 %
37.22	2.00	20	-60	79.00 %
37.22	0.00	20	0	79.00 %
57.80	20.58	20	-60	79.00 %
57.97	.17	10	0	79.00 %
113.35	55.38	10	-60	79.00 %
113.52	.17	0	0	79.00 %

FIGURE 5. PROFILE OUTPUTS AS PRINTED BY PROGRAM DMDB7 FOR THE LAST TWO PROFILES IN THE FILE SHOWN IN FIGURE 3.

represent tested profiles. The headers printed out with each profile show the date and time that Program DMDB7 was run followed by a line with the program name and depth increments and units. Note that in these particular profiles the units for all depth increments are FSW (feet of seawater). If the profiles were in metric format then MSW (meters of seawater) would have appeared after the depth increment. The next line of the header gives the name of the Model Parameter Input File (MPIF) which in this case was specified as HVAL09 in line 1 of the Profile Coordinate Input File in Fig. 3. Next to the MPIF name in parenthesis is the inert gas description from the MPIF. This description is used for labeling purposes only. In these examples the inert gas label is always HELIUM. Other examples of inert gas labels might be AIR, NITROGEN, 50/50 HE-N_2, etc. Finally, a profile identifier is printed out before the actual profile. Like the inert gas name the profile identifier is for labeling purposes only and is not used for any computations. The profile itself gives the cumulative or Zero Time of the profile and the Elapsed Time at each depth or for each depth change. The positive rates are unsigned and signify descents and the negative rates ascents. The last column shows whether an inert gas fraction (%) or oxygen constant partial pressure (ATA) was used by the model for updating the segment and what value was used.

The first profile is a simple no-decompression dive to 150 FSW. The profile was initialized on 79% inert gas (air in this case) and the rest of the dive was done using a constant 1.0 ATA PO_2 in helium. (The model used here always initializes assuming nitrogen is the inert gas, helium being assumed for the remainder of the dive). The first two entries at 0 FSW are the result of the initialization then a third 0.0 min entry at 0 FSW is made when the switch to 1.0 ATA PO_2 is made. Descent to 150 FSW takes 2.5 min and 11.53 min has been computed as the maximum time which can be spent at 150 FSW without requiring decompression stops. Ascent to the surface takes 2.5 minutes. Notice that a 0.0 min stop at 10 FSW was computed. As mentioned earlier all decompression profiles will always have at least a 10 FSW stop so the model parameters will be recorded at least once before the surface is reached.

The second profile is initialized exactly the same way as the first but 27.5 min is spent at 150 FSW. Notice in Fig. 3 line 19 that 30 min was specified as the time at 150 FSW before ascending to 0 FSW at 60 FPM. However, since the "TX" option was specified in line 20 the 2.5 min descent time was subtracted by the program from the 30 min Bottom Time resulting in 27.5 min being spent at 150 FSW. Also, in line 20 of Fig. 3, the "FN" option was specified indicating that this was the last line of this dive profile. The program computed the stop depths and times at 30, 20 and 10 FSW before going on to the next profile. The first stop is at 30 FSW and it takes 2 min to get there. A 3.06 min. stop is taken before ascending to 20 FSW which takes .17 min. The last profile entry is a .17 min ascent from 10 FSW to the surface after an 11.30 min stop.

The third profile illustrates the use of the "DX" option. Note from Fig. 3 that the profile description is identical to that of the second profile except for the inclusion of the "DX" option in line 30. This option overrides the automatic decompression feature and ascent is made directly to the surface. The usefulness of the "DX" option is not obvious from the

profile printout but is better appreciated by looking at the Model Profile Parameter Printout which will be described later in this report. It is usually used in anlayzing profiles produced by other models where all stops are explicitly specified and where anlaysis of these profiles using the current model is desired.

The fourth profile (Fig. 5) is similar to the second profile except the "LS" option is used to take the last stop at 20 FSW. After stopping at 20 FSW a direct ascent to the surface is made. However, a 0.0 min 10 FSW stop is still computed so that the Decompression Model Parameters will be computed and recorded every stop depth increment until the surface is reached. In this case there is no advantage to taking the last stop at 20 FSW since the total decompression time is the same as in the second profile.

In the fifth profile, a switch from a 1.0 ATA constant PO_2 to a 79% inert gas fraction is made at 20 FSW. Line 49 in the input file in Fig. 3 generates the profile up to Zero Time 35.22 min. Line 51 in Fig. 3 takes a 0 min stop at 20 FSW and switches to an inert gas fraction of 79%. In the Profile Output, two more entries are made at 20 FSW. Both are for 0 min so two additional entries at a zero time of 35.22 min are made. The only thing that has happened during this 0.0 min stop is that the gas switch was made. Line 53 in Fig. 3 specified a 2 min stop before ascending to the surface at 60 FPM. The 2 min stop causes two additional entries to be made at 20 FSW, both at 37.22 min. The first is the 2 min stop and the second a 0 FSW depth change. The reason there was no depth change is that the Model determined that additional time had to be spent at 20 FSW before ascending. The Model computed a 20.58 min additional stop time at 20 FSW then a 55.38 min stop at 10 FSW before ascending to the surface. Since "FN" was specified in line 54 of Fig. 3, the profile is done. Line 56 of Fig. 3 is "NO" signifying that no further profiles follow.

All profiles in Fig. 3 specified printouts of the Model Profile Parameters. These will be discussed later when the Decompression Model is presented. Also note that the "TX" option was used in all profiles so that the descent time to 150 FSW was subtracted from the specified time at 150 FSW. This option allows one to enter times as U.S. Navy Bottom Times which are defined as descent time plus actual time at depth.

In all of the above examples only "square dive" profiles were shown, that is, descent to some depth for a specified time with ascent to the surface. Fig. 6 shows the Profile Coordinate Input File and Profile Output for a complicated multiple depth dive showing how multiple depth dives are handled.

Program TBLP7

This program is basically the same as Program DMDB7 with the exception of some constraints on the Profile Coordinate Input File, a different output format, and rounding off of all bottom and stop times to whole numbers. A complete listing of Program TBLP7 is found in Appendix A-2 and only the differences between Program TBLP7 and DMDB7 will be discussed.

PROFILE COORDINATE INPUT FILE

0001	HVAL09
0002	1,10
0003	150/30
0004	.79,1.0
0005	0,0,60
0006	F1
0007	0,150,60
0008	P1
0009	30,60,60
0010	P1TX
0011	60,90,60
0012	P1
0013	30,120,60
0014	P1
0015	40,30,60
0016	P1
0017	20,50,60
0018	P1
0019	30,0,60
0020	P1
0021	120,0,60
0022	F1
0023	0,200,60
0024	P1
0025	60,50,30
0026	P1
0027	120,150,30
0028	P1
0029	60,30,60
0030	P1
0031	120,0,30
0032	P1FN
0033	YES
0034	NO

PROFILE OUTPUT

1:21 PM TUE., 5 JAN., 1982
PROGRAM DMDB7 USING 10 FSW STOPS
HVAL09(HELIUM)

150/30

ZERO TIME	ELAPSED TIME	DEPTH	RATE	GAS
0.00	0.00	0	60	79.00 %
0.00	0.00	0	0	79.00 %
0.00	0.00	0	60	1.00 ATA
2.50	2.50	150	0	1.00 ATA
30.00	27.50	150	-60	1.00 ATA
31.50	1.50	60	0	1.00 ATA
91.50	60.00	60	60	1.00 ATA
92.00	.50	90	0	1.00 ATA
122.00	30.00	90	60	1.00 ATA
122.50	.50	120	0	1.00 ATA
162.50	40.00	120	-60	1.00 ATA
164.00	1.50	30	0	1.00 ATA
184.00	20.00	30	60	1.00 ATA
184.33	.33	50	0	1.00 ATA
214.33	30.00	50	-60	1.00 ATA
214.83	.50	20	0	1.00 ATA
225.37	10.53	20	-60	1.00 ATA
225.53	.17	10	0	1.00 ATA
294.16	68.62	10	-60	1.00 ATA
294.32	.17	0	0	1.00 ATA
414.32	120.00	0	60	79.00 %
414.32	0.00	0	0	79.00 %
414.32	0.00	0	60	1.00 ATA
417.66	3.33	200	0	1.00 ATA
477.66	60.00	200	-30	1.00 ATA
481.66	4.00	80	0	1.00 ATA
492.24	10.58	80	-30	1.00 ATA
492.57	.33	70	0	1.00 ATA
503.71	11.13	70	-30	1.00 ATA
504.04	.33	60	0	1.00 ATA
515.17	11.13	60	-30	1.00 ATA
515.50	.33	50	0	1.00 ATA
635.50	120.00	50	30	1.00 ATA
638.84	3.33	150	0	1.00 ATA
698.84	60.00	150	-60	1.00 ATA
700.50	1.67	50	0	1.00 ATA
708.00	7.50	50	-60	1.00 ATA
708.17	.17	40	0	1.00 ATA
749.75	41.58	40	-60	1.00 ATA
749.92	.17	30	0	1.00 ATA
869.92	120.00	30	-30	1.00 ATA
870.25	.33	20	0	1.00 ATA
908.11	37.86	20	-30	1.00 ATA
908.45	.33	10	0	1.00 ATA
1038.24	129.79	10	-30	1.00 ATA
1038.57	.33	0	0	1.00 ATA

FIGURE 6. MULTIPLE DEPTH DIVE PROFILE COORDINATE INPUT FILE AND PROFILE OUTPUT. SEVENTY NINE PERCENT INERT GAS BREATHED DURING ALL INTERVALS AT 0 FSW. BOTH 60 FSW/MIN AND 30 FSW/MIN RATES USED.

First the input file constraints will be discussed. All Profile Coordinate Input Files compatible with Program TBLP7 will work with Program DMDB7 but the reverse is not true. As with Program DMDB7, all rates specified in the input file must be non-zero numbers but they must all be whole numbers greater than 1. However, in Program TBLP7, the very first rate on the very first profile coordinate input line of the file will be used for all subsequent profiles. Also, the first gas tensions input for the first profile will remain in effect for all subsequent profiles. Each profile description for Program TBLP7 must be as shown in Fig. 7. Tissue gas tensions are initialized at the surface and changed just before descent begins. If no gas switch is desired, then one specifies the same inert gas option for both option lines. If this convention is not followed, then the bottom times and stop times will not appear in their proper spot in the printout. Also note that the "TX" option must always be used for decompression dives and that the time specified in the seventh line of each profile must not only be a whole number but must also include descent time. Profiles used with Program TBLP7 must be "bounce dives", that is, descent is made directly to some depth, time is spent at that depth, and then decompression to the surface occurs. Program TBLP7 will accept only "bounce dive" profiles and only one descent and ascent are allowed. Once ascent is begun, it may be stopped to switch breathing gases but no descents must occur; only continued ascents to the surface with intervening stops. The "LS" option allows the last stop to be taken at any desired depth; however, it is up to the user to ensure that in fact a sufficient stop can be taken at the specified depth to allow ascent to the surface. If the last stop depth specified is too deep, a stop time of 9999 min will be returned.

Program TBLP7 expects all profiles in the input file to be described in exactly the same way. The only differences allowed between profiles are the bottom times and depths.

The way in which Program TBLP7 rounds off times depends on what the time is. First of all, all depths and times specified in the Profile Coordinate Input File must be whole numbers. When a no-decompression time is computed the program adds the descent time, truncates the result, and subtracts the descent time. Thus, all no-decompression times are rounded down to the nearest decimal number which when added to the descent time will give a whole number. When the program computes a stop time it adds 0.9 min to the value and truncates the result. However, no matter how small the stop time the minimum stop time will be 1 min. It should be noted that all roundoffs occur before any model updates are done so that the actual rounded off stop times are used to update the model during ascent. In certain cases, when a deeper stop has been rounded up, the additional decompression will allow the next shallower stop to be a minute shorter.

As Program TBLP7 computes each decompression schedule the depths and times are stored in an array. After the decompression schedule computation has been completed the schedule is not immediately printed but is recorded in an output buffer which can hold up to one page of schedules. Only when enough schedules have been recorded to fill the buffer are the schedules printed in table format, a page at a time.

TBLP7 Profile Coordinates

Profile Identifier

Gas Tensions

0, 0, Rate

Options

0, Depth 1, Rate

Options

Time, Depth 2, Rate

Options (TX)

⋮

TIME, Depth N, Rate
Options (FN)
Yes
Yes ("No" if last profile)

FIGURE 7. Profile description format for the Profile Coordinate Input File used with Program TBLP7. Each profile description must comply with this format. Depth 1 is the bottom depth and Time is the Bottom Time. Depth 2 must be less than Depth 1 and all subsequent depth entries must be equal to or less than the preceding depth entry. The TX Option must always be specified in the eighth line of each profile description.

Program TBLP7 does not contain the Subroutine RCRD7 so Model Profile Parameters are not recorded. If this information is desired, Program DMDB7 should be used.

Program Initialization Procedure
(Lines 193 - 245)

This is the same as in Program DMDB7 with three additional functions being performed in line 237-244. The array DSTOPS is filled with the permissible stop depths which are a function of the maximum number of stops (NSTOP) and the stop depth increment DINC (line 225-227). The maximum number of stops is dictated by FORMAT Statements 50-64 (lines 172-186). It must be remembered that if the value of NSTOP is changed, then FORMAT Statements 43 and 50-64 may have to be modified accordingly. The maximum bottom time (BTMAX) and maximum total dive time (TDTMAX) are set to their desired values in lines 243 and 244 which will restrict the schedules which will eventually be printed depending on bottom time and total dive time values.

Profile Initialization Procedure
(Lines 258 - 289)

In Program TBLP7, the inert gas tensions and rate are read in for the first profile only and these values used for all subsequent profile coordinate inputs in the Profile Coordinate Input File. The first RATE is integerized by assigning it to IRATE (line 286) so fractional rates are not allowed.

Profile Generation and Update Loop
(Lines 304 - 436)

Statement 210 does not read a rate as it does in Program DMDB7 but RATE is always set to the value of IRATE, which was specified by the first profile. Lines 374-377 specify how no-decompression limits are computed. Since all bottom times must be whole minutes, the actual time at depth must be adjusted so that when it is added to the descent time later in the Profile Recording Procedure a whole number results. Subroutine NLIM7 returns the exact no-decompression bottom time which may be 0.0 min. First the no-decompression time is adjusted in line 361 so the Bottom Time will not exceed the maximum value specified in line 233. In line 377 a time at depth is computed which when added to the descent time will be a whole number. This is no problem as long as when TIME is added to the descent time (T(K-1)) on the right hand side of the equal sign the result is greater than if T(K-1) was rounded up to the next minute. If it is not then a negtive value will result when T(K-1) is subtracted from the truncated value of T(K-1). To prevent this the minimum time added to T(K-1) is .99 min. This ensures that

the Total Bottom Time will never be less than the descent time. Since the value of TIME computed in line 377 is input into the profile generation procedure, if it will require decompression stops they will be computed. Thus, some dives may have no no-decompression limit, decompression stops being required even if ascent is begun immediately after descent.

The legal options for Program TBLP7 are the same as those for Program DMDB7 to retain compatibiltiy. However, the "DX" is meaningless when used with Program TBLP7 and the "TX" option must always be used in the eighth line of each profile (Fig. 7).

Statement 219 (line 383) adds 0.001 min to TIME to prevent any roundoff error from causing the integerized time values in the output procedure to be truncated to the next lower minute. The Subroutine RCRD7 is not used and gas tensions and gas tension labels are not recorded as they are in Program DMDB7 because they are not needed on output.

First Stop Depth Computation Procedure (Lines 454 - 477)

This is identical to that used in Program DMDB7.

Stop Time Computation Procedure (Lines 499 - 545)

This is the same as that used in Program DMDB7 except that all exits back to Statement 220 are via Statement 440 (line 540) so the stop times will be rounded up to the next 0.9 min. This means that stop times are rounded down only if they exceed a whole minute by less than 6 seconds. However, non-zero stop times are never rounded down to less than 1 minute (line 540).

Profile Recording Procedure (Lines 563 - 681)

This procedure has no counterpart in Program DMDB7. After each decompression schedule is computed it is stored in array IPRO for later printout. Each time IPRO fills up a page of schedules is printed before any further schedules are computed. IPRO can hold 26 schedules but only 25 schedules are printed per page. This allows the 26th schedule to be computed and stored before the other 25 schedules are printed. After printout, the schedule in the 26th position is moved to the first position in IPRO and schedule computation and recording continues. The structure of IPRO is shown in Fig. 8.

The procedure begins by ensuring in line 568 that the first stop depth contained in D(6) is not greater than the maximum value allowed by the output format (which is currently 15 stop depth increments). If it is, recording is skipped. Next the counter K is decremented by one so it points to the last

OUTPUT ARRAY ELEMENT	PARAMETER NAME	DECOMPRESSION PROFILE ARRAY ELEMENTS
IPRO (1, N)	Depth	D(5)
(2, N)	Bottom Time	ZT(5)
(3, N)	Time to First Stop (min.)	T(6)
(4, N)	Time to First Stop (10's sec.)	
(5, N)	Time to First Stop (1's sec.)	
(6, N)	150 FSW Stop Time (min.)	T(K-29)
(7, N)	140 FSW Stop Time (min.)	T(K-27)
⋮	⋮	⋮
(20, N)	10 FSW Stop Time (min.)	T(K-1)
(21, N)	Total Ascent Time (min.)	ZT(K)-ZT(5)
(22, N)	Total Ascent Time (10's sec.)	
(23, N)	Total Ascent Time (1's sec.)	
(24, N)	Total Number of Stops	

FIGURE 8. Output Profile Array structure for the Nth decompression schedule. Each schedule may only have 24 elements in IPRO which restrict schedules to those having the first stop at 15 stop depth increments or shallower.

entry in the profile arrays. Then the Zero Time is computed by serially summing the time increments in array T (line 573-575). At line 586 the total dive time, ZT(K), is compared to the maximum value (TDTMAX) which was specified in line 244. As long as TDTMAX is not exceeded, control goes to Statement 513 (line 585) where the logical variable NORCRD is set to "false" and recording proceeds. When TDTMAX is exceeded for the first time, NORCRD will be "false" and control will drop through to line 583 where it will now be set to "true". Control then goes to Statement 515 where recording proceeds normally for this profile. However, if the Total Dive Time is still greater than the maximum value the next time through line 583 will transfer control to Statement 560 (line 668) thus skipping the recording procedure. The overall effect of this is that the first profile with a Total Dive Time which exceeds the maximum is recorded but subsequent profiles will not be until the Total Dive Time decreases to less than the maximum.

The four statements beginning at Statement 515 (line 590) check for other conditions which will determine whether or not a schedule will be recorded. The first schedule computed by the program (NPRO = 0) is always recorded. Also, if the maximum depth of the dive has changed from that of the previous profile the schedule is always recorded. In line 597 if the bottom time of a profile is less than that of a previous profile the decompression schedule is not recorded. The overall effect of lines 596 and 597 is that schedules with the same bottom depth are printed with progressively increasing bottom times. In line 598, if the schedule requires decompression stops it is always recorded. At this point, all schedules which reach line 603 are for no-decompression dives. Since the no-decompression time for a given depth may not be known in advance it is possible to have several schedules with progressively increasing bottom times which are all no-decompression dives. Since only the longest no-decompression time is of interest, these schedules are recorded without incrementing NPRO by skipping Statement 535 until the first schedule requiring decompression stops is encountered. Thus, no-decompression profiles overwrite the previously recorded one until the first decompression schedule requiring stops is encountered. All other recorded schedules increment NPRO at Statement 520 so they are recorded in the next available position in IPRO.

Lines 612 through 617 compute the Total Ascent Time (ASTIM), round it off to the nearest second, then records the whole minutes, tens of seconds and seconds units in the three separate elements in IPRO. Next, the Time to the First Stop (TFS) is rounded off and stored in the same manner as the ascent time (lines 622-628). Line 623 checks for no-decompression dives (depth of first stops, D(6) = DINC; stop time, T(7) = 0) and sets the Time to the First Stop and Total Ascent Time equal. Storing ASTIM and TFS in the manner described above makes for a nicer printout. Next, the dive depth and bottom time are recorded in lines 632-633.

Lines 638 through 661 contain the instructions for recording stop times in the proper elements of IPRO. LJ is computed in line 638 and will point to the element in IPRO which will contain the first stop depth. In line 642 the total number of stops is computed and stored in the last position in IPRO.

Fig. 8 shows the positions in IPRO for all permissible stops. As one records stops the usual case will be that after the first stop there will be only one stop every DINC depth increment (Profile 1 and 2, Fig. 4, Profile 4, Fig. 5). However, in some cases there may be more than one stop time at a given depth. In the fifth profile (Fig. 5), there are three separate stop times at 20 FSW (0 min, 2 min, and 20.58 min). Program TBLP7 will add all these together to get one 22.58 min stop and record the whole 20 FSW stop only once in IPRO. The variable ISTOP is initially set to the depth of the first stop (line 648) and is decreased one depth increment each time a stop time is recorded into IPRO (line 661). NK initially points to the position in array T just ahead of where the stop time is. The DO loop beginning at line 653 steps through all stops beginning at the depth of the first stop. The array IPRO has been filled with all zero's initially by a DATA Statement (line 151) and subsequently at line 787. The first stop time is added to the value in the first stop element in IPRO. NK is increased by 2 to point to the next stop depth. If it is still the same (line 660) control goes back to Statement 545 (line 654) where this stop time is added to the previous one. Thus, all stops at a given depth will be accumulated into a single stop time. When the next shallower stop depth is encountered, the next element of IPRO will be used to record the stop time.

After finishing the recording, the next record in the Profile Coordinate Input File is skipped. This line of input specifies whether or not the Model Profile Parameter Printout is desired and is only used in Program DMDB7. The next line of input specifies whether or not another profile will follow and the answer ("YES" or "NO") is read into the variable MORE. Next, a check is made to see if the buffer IPRO is full; if it is, a page of profiles is printed. Then if another profile follows, control is transferred back to Statement 200 (line 261) and the next profile read in. If no more profiles follow, then the contents of IPRO are printed out.

Table Printout Procedure
(Lines 696 - 808)

This procedure prints out a page of decompression schedules. A typical page is shown in Fig. 9. Lines 701-705 establish the value of ICONC which will point to the correct gas tension label in array CONLBL. Note that CP02 will have whatever value it had after computing the last schedule. Lines 709 through 717 print out all the header information. In line 723 the bottom depth of the first profile on the page is recorded so that when the depth changes, a special delimiter line can be printed out between groups of schedules with the same bottom depth. The DO loop beginning at line 728 prints out the schedules, one line at a time. If the profile depth has changed then a special delimiter line is printed and ICHNG is set to the new depth (line 736-739). The number of stops stored in the last position of the current row in IPRO specifies which WRITE Statement (line 751-779) will be used to print out that particular decompression schedule. This allows all stops deeper than the first stop to be left blank and makes for a nicer looking printout.

1:33 PM TUE., 5 JAN., 1982 TBLP7 VVAL18 (FEET)

.70 ATA FIXED PO2 IN NITROGEN DESCENT RATE 60 FPM ASCENT RATE 60 FPM

DEPTH (FSW)	BTM TIM (M)	TM TO FIRST STOP (M:S)	DECOMPRESSION STOPS (FSW) STOP TIMES (MIN) 150	140	130	120	110	100	90	80	70	60	50	40	30	20	10	TOTAL ASCNT TIME (M:S)
80	39	1:10															0	1:20
80	40	1:10															1	2:20
80	50	1:10															15	16:20
80	60	1:10															27	28:20
80	70	1:00														9	28	38:20
80	80	1:00														18	28	47:20
80	90	1:00														25	34	60:20
80	100	0:50													3	28	42	74:20
80	110	0:50													8	28	50	87:20
90	32	1:20															0	1:30
90	40	1:20															14	15:30
90	50	1:10														3	28	32:30
90	60	1:10														17	28	46:30
90	70	1:00													1	28	28	58:30
90	80	1:00													10	29	34	74:30
100	27	1:30															0	1:40
100	30	1:30															6	7:40
100	40	1:30															28	29:40
100	50	1:20														19	28	48:40
100	60	1:10													7	28	28	64:40
110	24	1:40															0	1:50
110	25	1:40															3	4:50
110	30	1:40															17	18:50
110	40	1:30														14	28	43:50
110	50	1:20													7	28	28	64:50

FIGURE 9. PAGE OF DECOMPRESSION TABLES AS PRINTED BY PROGRAM TBLP7. THESE TABLES ARE THE SAME AS THE 0.7 ATA CONSTANT PO2 TABLES FOUND IN REFERENCE 4.

After the contents of IPRO have been printed, the schedule in the last position is moved up to the first (remember that IPRO holds one more schedule than will fit on a page), and all other positions in IPRO are filled with zeros (line 785-788). NPRO is set to "1" signifying that only a single schedule is now in IPRO and a check made to see if more profile descriptions are present in the Profile Coordinate Input File. If MORE is "YE(S)" than a form feed is executed and program control goes to Statement 200 (line 261) to begin reading in the next profile. If no more profiles follow but the printout occurred because IPRO was full, control goes back to Statement 570 (line 674) to print out the last schedule before stopping. Finally, a delimiter line is printed below the last decompression schedule printed, a form feed is executed and the program stops.

PART 2

DECOMPRESSION MODEL

SUBROUTINES

Model Overview

There are 8 subroutines which comprise the MK 15/16 Decompression Model (Fig. 1). The Model is based on a maximum of 9 tissue tensions contained in an array. The number and halftimes of the tissues are specified in an input file along with the ascent criteria. The basis of the model is Subroutine UPDT7 which updates the tissue tensions over a specific time interval and depth change (one profile subsegment). In addition to updating the tissue tension, Subroutine UPDT7 also computes the Instantaneous Ascent Depth (IAD) which is the shallowest depth which could be ascended to instantaneously without violating the ascent criteria. In the course of developing the Decompression Model, two versions of Subroutine UPDT7 were used. Version 1 assumes exponential uptake and linear offgassing. This version is the one currently being used to compute the MK 15/16 Constant 0.7 ATA Oxygen Partial Pressure Decompression Tables for either helium or nitrogen inert gas. Version 2 was actually the first one tested and assumes exponential uptake and offgassing. This Version 2 of Subroutine UPDT7 updates tissue tensions according to the classical Haldanian approach assuming no gas phase forms and testing of decompression schedules computed in this way are reported in NEDU Report 11-80 (1). Each version of Subroutine UPDT7 has a corresponding version of Subroutine STIM7 associated with it. Subroutine STIM7 computes the amount of time required at a given depth before ascent can be made to a new depth. It is important that the proper version of STIM7 be loaded with the corresponding version of UPDT7.

Subroutine FRSP7 computes the depth of the first stop and is partially model independent since no assumptions are made in the subroutine about how tissue updating is done. It uses Subroutine UPDT7 to compute the IAD and goes through an interation to find the depth which can be ascended to at the specified rate without changing the IAD. Subroutine NLIM7 uses the gas uptake equations to get an estimate of the no-decompression time at a given depth but uses Subroutines UPDT7 and FRSP7 to optimize the no-decompression time to the nearest 0.3 seconds.

Subroutine BLOC7 initializes the variables in all the common blocks and Subroutine INIT7 initializes the Model by saturating all tissues at the specified starting depth. The final two subroutines perform input and output functions for the model. Subroutine RDIN7 reads in the Model Parameter Input File which contains the ascent criteria, Stop Depth Increment, Units of Depth input (feet or meters), tissue haltimes, number of tissues and Saturation-Desaturation Ratios. While some variation in the computed decompression schedules can be made by changing the values in the common blocks as specified by Subroutine BLOC7, the major changes in the decompression schedules are made by changing the values specified in the Model Parameter Input File, usually the ascent criteria. Subroutine RDIN7 will also print out the values in the Model Parameter Input File before the actual decompression profiles or tables are output. Subroutine RCRD7 performs two functions, in the record mode it stores tissue tension values and the corresponding zero time in an array, and in the output mode it prints these values out. These values are useful in analyzing the functioning of the Model in detail.

Subroutine BLOC 7

This subroutine intializes the data in the common blocks PARAM and BLDVL which are used by the other MK 15/16 Decompression Model Subroutines. A listing is found in Annex B-1. The Common Block PARAM contains the Model ascent criteria array M, the tissue tension array P, the tissue halftime array HLFTM, the number of tissues NTISS, the saturation-desaturation ratio array SDR and the value of IAD as computed by Subroutine UPDT7. The values assigned to this common block by the DATA Statement at line 38 are really default values since the I-O Program will usually assign values to these variables from the Model Parameter Input File. The Common Block BLDVL contains variables whose values are not usually changed by the Model Subroutines. These variables represent blood and intrapulmonary gas pressures and tensions. The values assigned to these variables in line 56 are all in feet of seawater (FSW) where 33 FSW = 1 ATA = 760 mmHg. While FSW may seem a strange unit for partial pressures, using it greatly simplifies the mathematics in many of the other subroutines. It must be noted that different decompression profiles or sets of tables may require different sets of values for variables in the Common Blocks initialized by Subroutine BLOC7. The values shown in Annex B-1 are appropriate to only certain decompression schedules. The values required in BLOC7 for the various decompression schedules tested during the MK 15/16 Decompression Model development will be described in Part 3 of this report.

Subroutine UPDT7

Subroutine UPDT7 updates model parameters over a single profile subsegment. It is the heart of the MK 15/16 Decompression Model since it describes all of the gas uptake and elimination processes. Two versions are presented. The one for the E-L Model is given in Annex B-2 and the one for the E-E Model is given in Annex B-3. No physiological rationalization will be presented for this subroutine here, only a detailed description of its operation.

Exponential-Linear Version

The listing for the E-L Version (Version 1) of Subroutine UPDT7 is found in Annex B-2. The corresponding version (Version 1) of Subroutine STIM7 is found in Annex B-5. The basis of Subroutine UPDT7 are two gas uptake and elimination equations which update up to 9 halftime tissues during linear depth changes. The E-L Model assumes that all gas stays in solution until the total tissue gas tension exceeds ambient hydrostatic pressure by an amount called the gas phase overpressure. While in solution gas uptake and elimination for linear depth changes are described by Equation 2 of Annex B-2 (line 317). This is called the exponential mode. When the total tissue gas tension exceeds the gas phase overpressure, a gas phase is assumed to form and gas elimination described by Equation 4 of Annex B-2 (line 493). This is

known as the linear mode. Most of Subroutine UPDT7 is concerned with finding the exact time at which the transition is made from Equation 2 to Equation 4. If the partial pressure of oxygen is constant finding the time of the transition from Equation 2 to Equation 4 is straightforward and is given in Statement 210 (line 363) of Annex B-2. If the fraction of inert gas is constant finding the crossover time requires an interative solution.

In cases where the tissue offgassing is initially described by Equation 4 the transition time at which crossover to Equation 2 occurs can always be found by explicitly solving Equation 3 for T. Equation 3 of Annex B-2 (line 489) describes the condition at the crossover time T and is a quadratic equation in the case of a constant inert gas fraction and a linear equation if the partial pressure of oxygen is constant (in the latter case the rate of change of oxygen tension, RO2, is Zero).

After finding the crossover time the tissue tensions are updated and then the Instantaneous Ascent Depth (IAD) is computed. The IAD is the shallowest depth which could be ascended to instantaneously without violating any of the ascent criteria contained in array M. The IAD is used by other Decompression Model Subroutines.

Initialization Procedure (Lines 140 - 167)

The variable IPRNT is set to "0" to suppress printout of iteration values. Setting it to "1" will cause all intermediate iteration values to be printed out each time the Newton-Raphson iteration is performed later on. The iteration values are always printed no matter what the value of IPRNT if more than ten iterations are performed without convergence. Note that there are four rates which are used in the subroutine. RATE is the rate of depth change passed from the main program and can be in feet or meters of seawater (FSW or MSW) per minute. This rate is converted to RAMB which is the rate of ambient pressure change and is always in FSW/min. RINRT is the rate of inert gas change and RO2 is the rate of inspired oxygen partial pressure change both of which are in units of FSW/min. If the oxygen partial pressure is constant then RO2 is zero and RINRT will equal RAMB. If the inert gas fraction is constant both RO2 and RINRT are non-zero and may or may not be equal.

Tissue Update Loop (Lines 183 - 608)

This DO loop contains the procedures for udpating the tissue gas tensions over a single profile subsegment. It is executed once for each of the NTISS tissues in the Model. In lines 189-192 the time constants for saturating and desaturating tissues are calculated as well as the initial values of PAN2 and PVSAT. Since these last two variables are changed during loop execution,

they must be updated to their initial values for each new execution. PVSAT represents the amount of inert gas in the venous blood if the blood is just saturated to ambient pressure, and PAN2 is the arterial inert gas tension. The initial tissue tension PTISS is set to the value stored in the tissue tension array P in line 196. P(I) will be updated to its new value at the end of each loop execution. Next, in line 201, the determination is made whether the tissue is initially in the linear (Equation 4) or exponential (Equation 2) mode. If PTISS exceeds PVSAT by the gas phase overpressure PBOVP, a gas phase is assumed to exist so it will be in the linear mode and control is transferred to the linear update procedure at Statement 300 (line 506). If not, no gas phase is assumed to exist so the tissue is in the exponential mode and the program drops through to the Exponential Node Time Computation Procedure.

Exponential Node Time Computation (Lines 220 - 294)

This procedure goes through several checks to see if the tissue tension will go through a maximum or minimum (node) during the subsegment time interval TC. Since either saturation or desaturation may occur in the exponential mode, logical variable DSAT is set to "true" or "false" to record the initial state of the tissue tension change in lines 230 and 231. The conditions for which no maximum or minimum will occur are checked for in lines 236, 242 and 250 and control transferred either to the exponential update procedure at Statement 400 (line 584) or to the procedure which will compute the time at which desaturation goes from the exponential to the linear mode at Statement 200 (line 337). At line 254, any remaining tissues will have a node and the time at which this node will occur is computed in line 257. Tissues which were completely saturated at the current depth will have a node at 0 min (the beginning of an ascent) and will be desaturating for the entire ascent. Since these tissues may crossover to the linear mode line 262 will transfer control to Statement 200. If the node will not occur during the subsegment time interval (TC) then the tissue will remain exponential and line 267 will transfer control to the exponential update at Statement 400. At line 273, all remaining tissues will have a node sometime during the time interval TC and PAN2 and PVSAT are updated to their values at the time of the node. The time remaining in interval TC after the node is computed for later use. Finally, at line 276, the tissue inert gas tension is updated to its value at the node which by definition will be the arterial inert gas tension. The tissue is initially assumed in line 280 to remain exponential for the remainder of the time interval but if it was initially saturating control goes to the Exponential-Linear Crossover Time Computation Procedure at line 337 because after the node it will be desaturating and desaturating tissues will eventually go to linear offgassing. Line 293 transfers control for initially desaturating tissues to the update at Statement 400 (line 584) after the variable DESAT has been set to "false" indicating that after the node the tissue will be saturating.

Exponential-Linear Crossover Time Computation Procedure
(Lines 334 - 472)

Tissues ending up at Statement 200 are all desaturating at this point and may go to the linear mode if the total tissue gas tension exceeds the ambient pressure by the gas phase overpressure (PBOVP) at sometime during the time interval (TI) remaining after the node has occurred. As T gets very large the exponential term in Equation 2 (line 317) goes to 0.0 and Equation 2 becomes the equation of the asymptote:

(5) $$P(I) = (PAN2-RINRT/K) + RINRT * T$$

The equation for the value of the tissue tension at the ambient pressure at which crossover will occur is:

(6) $$P_{XOVER} = PAMB - (PVO2 + PVCO2 + PH2O) + PBOVP + RAMB * T$$

Crossover will occur when $P_{XOVER} = P(I)$. If the straight line described by Equation 6 is to the left of the line described by Equation 5, then P(I) will have to assume a value of P_{XOVER} sometime as it approaches the asymptote. Since RAMB is always greater than or equal to RINRT, the line described by Equation 6 will be to the left of that described by Equation 5 if the intercept of the Equation 5 line is greater than that of the Equation 6 line. The condition for which this is true is given in line 343 of Subroutine UPDT7 and if met, control passes to statement 210 (line 363) where a crossover time is computed.

If the asymptote line described by Equation 5 is to the left of that described by Equation 6, crossover may not always occur. If the intercept of the Equation 5 line is below that of the Equation 6 line the two lines will intersect only if RINRT is less than RAMB. This cannot occur if the oxygen partial pressure is constant so crossover will never occur (line 348) and control goes directly to the Exponential Update at Statement 400. In line 352, the time where the lines described by Equations 5 and 6 intersect is computed and if this does not occur within the remaining time in the interval TI then no crossover will occur and line 357 transfers control to the Exponential Update. If intersection does occur within time TI, crossover may occur and the time T is used as a starting guess for the iteration and control passes to the iteration at Statement 220 (line 384).

Statement 210 can be arrived at only if the conditions in line 343 have been met as discussed above. The time computed here is the exact crossover time if the oxygen partial pressure is constant and if it is the iteration is skipped, control going directly to Statement 280 (line 455). If the fraction of inert gas is constant rather than the partial pressure, then this time will be the maximum time to crossover and is used as a starting point for the iteration to follow.

Newton-Raphson Iteration
(Lines 381 - 443)

Beginning at Statement 220, constants for the equations used in the iteration are computed and the number of iterations initially set to 0. In line 393 Y, represents the difference between the right and left hand sides of Equation 1 (line 313) and will be exactly 0.0 when the time T exactly equals the crossover time. DY in line 394 is the first derivitive of Y. The initial values of T as computed in line 352 or 363 and Y as computed in line 393 are used to start the iteration and the values of T, Y, DY and Y/DY for each execution of the iteration are stored in the array VALIT in case they are needed later. Line 413 specifies the convergence criteria and the loop is exited when they are met. Only ten passes are made through the iteration and if the convergence criteria have not been met by then the iteration is halted at line 417 and the values stored in VALIT are printed out. Under certain conditions the value of Y will oscillate around 0.0 and this condition is checked for in line 425 and 426. When this happens, lines 427 and 428 compute the maximum error for the time estimate and if it is less than 0.0001 min the iteration is halted. This substantially cuts down the number of iterations required in many cases. The old time estimate and value of Y are stored in T1 and Y1 and a new estimate of T is made before returning to the start of the iteration at Statement 230 (line 392).

Statement 270 (line 440) will cause the values stored in array VALIT to be printed if no convergence has occurred within ten iterations or if IPRNT was set to "1" in line 141. Control drops through to Statement 280 where the crossover time is assigned the value of T either from the Newton-Raphson Iteration or Statement 210 (line 363). If the crossover occurs outside of the remaining time interval TI, then line 456 transfers control to Statement 400 and the tissue is updated exponentially. If not, pertinent variables are updated to the crossover time in lines 463-470. The time remaining in the time interval (TLIN) is computed in line 471 and since the tissue will be in the linear mode line 472 transfers control to the Linear Update at Statement 450 (line 593).

Linear-Exponential Crossover Time Computation Procedure
(Lines 503 - 571)

In this procedure, Equation 3 (line 489) is solved for T. The equation can be put into quadratic form:

$$(7) \qquad (A * T**2) + (B * T) + C = 0$$

Constants A, B and C are given in lines 518-520. The variable D in line 521 is the square root term of the quadratic formula for the solution of Equation 7. If either B or D are less than 0.0 or if B equals 0.0, no

crossover will occur and line 525 transfers control to the linear update at Statement 450 (line 593). If the oxygen tension is constant then RO2 is 0.0 causing A to assume a value of 0.0, the square term disappears from Equation 7 and the crossover time is simply the ratio C/B (line 530). If the inert gas fraction is constant, the quadratic formula gives the solution for the crossover time and the root will always be the smallest of the two roots which is given in line 531. If the crossover time is outside the interval TC then the tissue will stay linear for the entire interval so control goes to Statement 450 (line 593). If not, then all pertinent values are updated to the crossover time and DESAT is set to "true" (line 542-545). Next the now exponential tissue is updated to its node (if it occurs in the remaining time) before going to the exponential update (line 550-571).

Tissue Inert Gas Update Procedures
(Lines 581 - 595)

Line 584 is the Exponential Update Equation 2 (line 317) and line 595 is the Linear Update Equation 4 (line 493). After P(I) is updated by the appropriate equation control goes back to the beginning of the loop at line 188 until all NTISS tissues have been updated.

Instantaneous Ascent Depth Computation Procedure
(Lines 625 - 636)

After all tissues have been updated then the Instantaneous Ascent Depth (IAD) is computed. The IAD is used by other Decompression Model Subroutines and is the shallowest depth which could be instantaneously ascended to without violating the ascent criteria. In the MK 15/16 Decompression Model the ascent criteria are contained in the array M which is a table of maximum tissue tensions for each depth increment. The values in the array are initiallly determined by analyzing existing tables and then they are adjusted empirically based on manned diving experience. The method of developing the values in the array M will not be covered here, but will be the subject of further reports. The array M has NTISS columns, one for each tissue compartment and 30 rows, representing depths from 1 stop depth increment to 30 stop depth increments. Assume that stop depth increments of 10 FSW have been chosen. Then the first row of the array M represents the maximum tissue inert gas tension at 10 FSW which will allow ascent to 0 FSW, the second row the maximum tissue inert gas tension at 20 FSW which will allow ascent to 10 FSW and so on. The IAD is found by comparing all tissue inert gas tensions to their respective maximum values starting at the 300 FSW row. If all tissue tensions are equal to or less than the values in this row of the array then ascent can be made to 290 FSW. This comparison continues until at least one tissue tension exceeds the maximum. At this depth further ascent would violate the ascent criteria so the depth of this row of array M is the IAD. The IAD is used as a first approximation for the depth of the first stop as will be discussed. Note that the maximum tissue tensions in array M are all in units of FSW but that the stop depth increment DINC is in meters or feet depending on the units used in the Profile Coordinate Input File.

After computing the IAD the tissue tension update is complete and the subroutine returns control to the main program.

Exponential-Exponential Version

The listing for the E-E Version (Version 2) of Subroutine UPDT7 is found in Annex B-3. This version must be used with the E-E Version (Version 2) of Subroutine STIM7 listed in Annex B-6. The E-E Version of Subroutine UPDT7 is similar to the E-L Version in that all tissues are first updated to their maximum or minimum nodes and there are separate time constants for uptake and elimination. In the E-E Version gas uptake and elimination are assumed to always be exponential, and it is assumed that no gas phase ever forms.

Initialization Procedure
(Lines 113 - 137)

Only PAMB, PA02 and RINRT are calculated. The other variables initialized in the E-L version are not used.

Tissue Update Loop
(Lines 152 - 257)

This loop is executed once for each of the NTISS tissues. In lines 157-159, the exponential time constant for uptake (KSAT) and elimination (KDSAT) are computed along with the arterial inert gas tension (PAN2). The initial tissue tension PTISS is initialized in line 163 to the appropriate value in array P.

Node Time Computation Procedure
(Lines 178 - 228)

This procedure is similar to the Exponential Node Time Computation Procedure in the E-L version. First, in lines 187-188, the value of DSAT is set to "true" or "false" depending on whether or not the tissue is saturating or desaturating. If the depth is constant (RATE = 0) there is no node and control passes directly to the update at Statement 400 (line 240). Also, there will be no node for saturating tissues undergoing descent or desaturating tissues undergoing ascent (line 192, 202). Both of these conditions cause immediate transfer of control to the Exponential Update Procedure at statement 400 (line 240). In line 209 the time of the node occurance is calculated using the saturation or desaturation time constant as appropriate. If this time is less than 0.0 or greater than the time interval TC control is transferred at line 214 to the Exponential Update Procedure. If the node does occur within the time interval TC the tissue inert gas tension and arterial inert gas tension are updated to the node and the time remaining after the node computed (line 220-222). The variable DESAT is complemented in line 227 and control drops through to the Exponential Update Procedure.

Exponential Update Procedure
(Lines 240 - 245)

This procedure updates the tissue for a linear ascent or descent. After the update is complete, control is transferred back to the beginning of the loop until all NTISS tissues have been done. After all tissues have been updated, control drops through to the procedure which computes the Instantaneous Ascent Depth.

Instantaneous Ascent Depth Computation Procedure
(Lines 273 - 284)

This procedure is identical to the one used in the E-L Version of UPDT7.

Subroutine FRSP7

This subroutine finds the depth of the first stop for a specified ascent rate. The depth of the first stop is passed back to the main program as an argument of the subroutine (DFS), all other data is passed in the three common blocks PARAM, BLDVL and MDATA. The subroutine uses the Instantaneous Ascent Depth (IAD) calculated by Subroutine UPDT7 as a first approximation of the first stop depth. A trial update at the specified rate is performed first to DINC deeper than the IAD then if all ascent criteria are met at DINC+IAD to IAD itself. Depending on the rate of ascent and the initial tissue tensions the tissues may saturate or desaturate during the trial ascent and may have taken up excess gas (in which case the new IAD after ascent will have increased), offgassed sufficiently to go shallower (in which case the new IAD will have decreased) or still have just enough gas on board to require a stop at IAD (in which case the IAD will not have changed). Depending on whether the IAD has increased or decreased after the trial ascent, the first stop depth estimate is increased or decreased in increments of the stop depth increment (DINC) until the IAD before and after ascent are the same and are in fact equal to the depth which has just been ascended to.

Initialization Procedure
(Lines 105 - 119)

The depth of the first stop (DFS) is initially set to the current depth and if the current depth is equal to or shallower than the IAD, CDEPTH becomes the first stop depth. This precaution is necessary for two reasons. The first is that if the DX option is used for an ascent one could end up at a depth shallower than the IAD. If the DX option were not specified for the next ascent, the subroutine would attempt to descend to the IAD causing a negative descent time to be computed. Rather than have that happen, a stop will simply be taken at CDEPTH until ascent is possible. The second situation will occur if a 0 min stop is taken at a decompression stop during ascent (as in changing breathing gases) in which case the current depth will be equal to the IAD. In this case (unless precautions are taken) a trial

descent would be performed to DINC+IAD causing the tissue tensions to increase and an anomalous stop to be taken at DINC+IAD. In the auto-decompression mode one can never go too shallow so the depth of the first stop will never be deeper than the current depth. Line 110 ensures this is always the case.

In lines 115 to 118 the logical variable LASTIT is initialized to "false" and the current tissue tensions and IAD stored temporarily because they will be changed when Subroutine UPDT7 is called to do the trial ascent.

Depth of First Stop Iteration Loop
(Lines 133 - 191)

The variable MIND is set initially to the IAD and in lines 137-143 a trial update is done from the current depth to MIND+DINC. This must be done because the definitions of the ascent criteria requires that they be met DINC deeper than a given depth before ascent to that depth is possible. In lines 144 and 145 the tissue tensions and IAD are restored to their original values. If after ascent to MIND+DINC the IAD has increased, control is transferred by line 152 to line 161 where it will drop through to line 173. If the IAD has remained the same or decreased during the first trial ascent lines 153-155 do another trial ascent to IAD. If the new IAD equals MIND (the value of IAD before ascent) then line 161 transfers control to Statement 50 (line 188) where the value of the depth of the first stop (DFS) is set to MIND and the subroutine exited.

If IAD and MIND are not equal after the trial ascent then control goes to line 173. Since additional tissue saturation or desaturation takes place during ascent it is unlikely that MIND and IAD will be equal the first time through the loop. The usual sequence of events is that the value of MIND is systematically increased or decreased and by the second iteration the value of IAD doesn't change after the trial update and the loop is exited at line 161 with MIND containing the value of the depth of the first stop. In a very few cases, however, the IAD may increase on one pass through the loop and decrease on the next. This occurs when a tissue is still saturating during ascent. On the first trial update all tissue tensions will be less than their maximum permissible values contained in array M and the new IAD decreases by one depth increment after the trial update to the original value of IAD. The next time through the loop the trial update will be to the new value of IAD. If a tissue was saturating during ascent it may have taken up enough additional gas during the additional ascent to the new IAD to just exceed its maximum permissible value. Thus, when the next trial update is done the value of IAD will decrease by one depth increment. This oscillation will continue indefinitely because the tissue will have a tension just below its maximum permissible value at the deeper trial stop and just above it at the shallower trial stop. Since the ascent criteria state that once the maximum permissible tissue tension has been reached at a given depth that ascent to the next shallower depth increment is allowed the depth of the first stop is taken at the shallower of the two depths, and assigned to MIND.

Once the depth of the first stop has been found the IAD is restored to its original value, the value of the integer MIND is assigned to the real variable DFS and the subroutine returns control to the main program (lines 188-191).

Subroutine STIM7

This subroutine computes the time which must be spent at a given depth before ascent to a shallower depth can be accomplished without violating the ascent criteria. Subroutine STIM7 is never called before Subroutine FRSP7 has been called to first establish the depth of the first stop. Once the depth of the first stop has been established, Subroutine STIM7 is usually called to see how much time must be spent at a given stop before ascending one depth increment to the next shallower stop. However, provision is made for ascent to any depth after stopping and in situations where the next shallower stop is more than one stop depth increment shallower, a special optimization procedure is used to shorten the stop time to take advantage of any additional decompression which may occur during ascent.

Ascent may be limited by one of two phenomena. A desaturating tissue will be offgassing and its tissue tensions must decrease to the maximum permissible value as specified in array M before ascent is allowed. In these cases, the stop time is regulated by the desaturation time. In other cases, a tissue may be saturating and the stop time will be determined by the time it takes this tissue to saturate to its maximum permissible value. This is called the saturation time. Either the saturation or desaturation time is computed for each of the halftime tissue and the longest desaturation time and the shortest saturation time is saved. After the saturation or desaturation time has been computed for all NTISS tissues, the shortest of either the saturation or desaturation time becomes the stop time. The next depth to be ascended to after the stop (SDEPTH) and the stop time (TIME) are passed as subroutine variables. Two versions of Subroutine STIM7 are presented. The E-L version (Version 2) is used with the E-L version of Subroutine UPDT7 in Annex B-2 and the E-E version (Version 2) is used with the E-E version of Subroutine UPDT7 in Annex B-3.

Exponential-Linear Version

The listing of this version of Subroutine STIM7 is found in Annex B-5.

Initialization Procedure
(Lines 119 - 140)

In lines 122, 127-136, the ambient pressure, arterial oxygen tension and the venous and arterial inert gas tension are computed. In line 134, the desaturation time is initialized to its smallest possible value (0.0) and in line 135 the saturation time is initialized to its largest possible value (9999 min) which is considered an infinite time. Finally, in line 139, the depth or row subscript of array M which is associated with the next shallower depth SDEPTH is computed. It is this row of maximum permissible tissue tensions which must not be exceeded before ascent to SDEPTH can be accomplished.

Trial Desaturation and Saturation Stop Time Computation Procedure (Lines 158 - 258)

This procedure is executed once for each of the NTISS tissues in the model. In lines 165 and 166 the saturation and desaturation time constants for the tissue under consideration are computed. Then in line 170 control is passed to the Saturation Trial Stop Time Computation at Statement 100 (line 239) if the tissue is saturating. It it is not, control drops through to the Desaturation Trial Stop Time Computation.

Desaturation Trial Stop Time Computation (Lines 177 - 229)

In lines 181 and 182, the Trial Stop Time is set to 0.0 if the tissue tension is already less than or equal to the maximum permissible tissue tension at SDEPTH. In line 187 and 188, the Trial Stop Time is set to 9999 min (infinity) if the arterial inert gas tension is greater than or equal to the maximum permissible value. It must be remembered that all tissues which are desaturating will approach the arterial inert gas tension asymptotically, so if the arterial inert gas tension is greater than or equal to the maximum permissible value in array M, ascent to SDEPTH will never be possible.

Once it has been determined that a tissue can have a non-zero finite positive stop time, it must be determined whether the tissue is decaying linearly or exponentially. If the dissolved tissue tension is less than or equal to the venous inert gas tension, then the gas phase will have disappeared and the tissue will be decaying exponentially. By setting PLIN to the dissolved tissue tension in line 195 in these cases, the stop time for the linear portion of the tissue desaturation as computed in line 203 will be 0.0. If the dissolved inert gas tension is greater than the venous inert gas tension then PLIN is set to PVN2 in line 201 because when the tissue has desaturated to this value, further desaturation will be exponential. If the maximum permissible inert gas tension is greater than the venous, the tissue will have satisfied the ascent criteria without ever entering the exponential mode so PLIN is set in line 202 to the maximum permissible value in array M,so that the stop time for the exponential portion of the desaturation as computed in line 214 will be 0.0. After computing the time required for linear desaturation in line 203, the procedure will fix the time spent in the exponential mode to 0.0 if the maximum permissible inert gas tissue tension is above the venous (line 209-210). The time for the exponential portion of the desaturation is computed in line 215 and the exponential or linear times are summed in Statement 40 (line 219) to get the total stop times for this particular desaturating tissue. In line 224, it is assured that the largest stop time which can be computed is 9999. minutes. Finally, at Statement 50, the largest desaturation time computed so far is saved as TDSAT before either proceeding on the next tissue or exiting the loop if all NTISS tissues have been done.

Saturation Trial Stop Time Computation
(Lines 235 - 258)

Saturating tissues always stay exponential and a positive finite stop time will exist if the dissolved inert gas tension is less than the maximum permissible value in array M (line 246). The saturation stop times are computed in line 250 but can never be negative (line 251). A negative stop time might occur because of roundoff error causing the log argument function to be less than 1.0 in line 250. The shortest saturation time is saved in line 256 before doing the next tissue or exiting the loop.

In line 267 the smallest of the saturation or desaturation stop times is assigned to TIME as the stop time. Line 271 will terminate the subroutine if the depth to be ascended to after the current stop is not more than one DINC shallower than the current depth. Also, the subroutine is terminated if a non-zero positive finite stop time was not found (line 275).

Stop Time Optimization Procedure
(Lines 292 - 350)

If ascent is to be greater than DINC and a non-zero positive stop time exists, then it may be possible to shorten the stop time to take advantage of the additional decompression. The two logical variables used in this procedure are initialized in lines 295 and 296 and the current tissue tension and IAD stored temporarily in lines 300-302 anticipating the trial update by Subroutine UPDT7 which will change these values. In lines 306 -309, a trial update for the trial stop time previously calculated at the current depth is done and Subroutine FRSP7 called to compute the depth of the first stop (DFS). If the value of DFS as returned by Subroutine FRSP7 is greater than SDEPTH (the next shallower stop depth) the first time through the procedure, no optimization is possible. This usually means a tissue is saturating during ascent and will actually exceed the maximum permissible tissue tension at SDEPTH when it is reached. If DFS is less than or equal to SDEPTH, optimization may be possible.

In lines 313-315, the tissue tensions and IAD are restored to their original values. Line 319 will transfer control to Statement 430 (line 340) if the value of DFS is greater than SDEPTH. If it is not, FIRSTM is set to "false" signifying that the first pass through the procedure has been completed. In line 329, if the stop time is 0.0 or if IDFS has been set to "true" in line 348 on a previous pass, the optimization is over and the subroutine is terminated. In line 334, the stop time is shortened by 0.1 min (but never to a value less than 0.0) before returning to Statement 400 (line 300) for another update. Shortening of the stop time will occur until the value of DFS as computed by Subroutine FRSP7 in line 311 just exceeds SDEPTH.

When DFS exceeds SDEPTH, control is transferred at line 319 to Statement 430 (line 340) and if this happens the first time through the procedure (FIRSTM is "true"), the subroutine is terminated because optimization is not possible. If it is not the first time through then the stop time is increased in .005 min increments. IDFS is set to "true" so that as soon as the stop time has been increased sufficiently to cause DFS to equal SDEPTH, line 329 will cause the subroutine to terminate.

Exponential-Exponential Version

The E-E Version of Subroutine STIM7 should only be used with the E-E version of Subroutine UPDT7. The E-E Version of Subroutine STIM7 is basically the same as the E-L Version except that the linear portion of the gas elimination is assumed not to take place, both gas uptake and elimination being assumed exponential. A listing of this version of Subroutine STIM7 is found in Annex B-6.

Initialization Procedure
(Lines 117 - 137)

The venous inert gas tension does not appear in this subroutine and is not initialized. Otherwise the procedure is the same as for the E-L Version.

Trial Desaturation and Saturation Stop Time Computation Procedure
(Lines 155 - 231)

The major difference in this section from the E-L Version is the procedure for finding the trial stop time for desaturating tissues. Since all offgassing is exponential once it has been verified that conditions at the stop will allow decay to the maximum permissible level in array M in lines 179 and 185, only the exponential stop time has to be computed (line 189). The procedure for finding the stop time for saturating tissues is identical to that in the E-L Version.

From line 236 on, the E-E version of STIM7 is identical to that portion of the E-L version beginning at line 264 in Annex B-6.

Subroutine NLIM7

Annex B-7 contains the listing for this subroutine. This subroutine finds the maximum time which can be spent at the current depth which will allow direct ascent to the surface without violating the ascent criteria. The no-decompression time is passed as the variable TIME with the subroutine.

The no-decompression time is first estimated by computing the time it takes for each tissue to exponentially saturate to a level where the tissue tension just equals the maximum permissible value at 1 ATA (that is, the values in the first row of array M). The trial no-decompression time is the shortest of all the times computed for each tissue. Since this trial no-decompression time assumes instantaneous ascent, an optimization procedure is performed which will lengthen or shorten the trial no-decompression time until the tissue tensions are exactly equal to their maximum permissible values at the surface after a linear ascent at a finite rate.

Initialization Procedure
(Lines 112 - 125)

The logical variable IDFS which is used later on in the Optimization Procedure is set to "false". The ambient pressure, arterial oxygen tension and arterial inert gas tensions are computed and the no-decompression time is initialized to 9999 min which is defined as being essentially infinite.

Trial No-Decompression Time Computation Procedure
(Lines 141 - 166)

This procedure is a DO loop which is executed once for each of the NTISS tissues. If the tissue tension already exceeds its maximum permissible value, the trial no-decompression time is set to 0.0 min (line 147, 148). If the arterial inert gas tension is less than the surfacing maximum tension then the tissue can surface without decompression even after saturating and the no-decompression time is set to 9999 min (line 153, 154). In lines 158-163, the trial no-decompression time is computed for all other tissues and the smallest value saved as the final trial no-decompression time in line 164.

If the trial no-decompression time is 0.0 or 9999 then optimization is not possible and line 179 transfers control to Statement 40 (line 241) and the subroutine is exited.

No-Decompression Time Optimization Procedure
(Lines 190 - 231)

The current tissue tensions in array P are stored in array TP (the IAD was temporarily stored in line 175) anticipating a trial update by Subroutine UPDT7 which will change the tensions in array P as well as the IAD. In lines 198-201 a trial update at the current depth is done and then Subroutine FRSP7 is called to find the depth of the first stop. Following this, the tissue tensions in array P are restored to their original values in lines 205 and 206.

If the depth of the first stop (DFS) is not 0.0 then some gas uptake is taking place during decompression and the trial no-decompression time is too long. If DFS is 0.0 then all one can say is that the trial no-decompression time is not too long but it may be too short. The remainder of the procedure beginning at line 210 will add time in 0.1 min increments to the trial no-decompression time (line 218) until DFS is no longer 0.0. At this point, one can say that at the most the no-decompression time is 0.1 min too long. Since DFS will now exceed DINC, line 210 transfers control to Statement 30 (line 225) where the trial stop time is shortened in 0.005 min increments. Since IDFS was set to "true", as soon as the trial no-decompression time has been shortened sufficiently such that DFS is again 0.0 then line 217 will transfer control to Statement 40 where the subroutine is exited. If the trial no-decompression time at any time decreases to 0.0 then line 230 will immediately transfer control to Statement 40. If a finite positive time results from the optimization procedure it will be at the most .005 min (0.3 sec) too short.

Statement 40 restores the IAD to its original value and the subroutine is exited.

Subroutine INIT7

In this subroutine the model is initialized at CDEPTH. CDEPTH is usually 0.0 but may be any value. All tissue inert gas tensions are set equal to the arterial inert gas tension at CDEPTH. A listing is found in Annex A-8.

Subroutine RCRD7

This subroutine which is listed in Annex B-9 has two modes. If MODE is "1" then line 90 transfers control to the printout procedure beginning at Statement 200 (line 136). Otherwise, control drops through to the recording procedure.

Recording Procedure
(Lines 100 - 121)

The tissue tensions in array P are recorded in array TT in the row specified by CNTR. If this is the very first record, line 108 causes line 109 to be skipped so that the recorded Zero Time will retain the value of "0" set in the DATA Statement in line 76. Otherwise, line 109 sums the elapsed time since last recording Zero Time with the previous Zero Time to get its current value. Tissue gas tensions are stored in columns 1 through 9 of array TT, Zero Time in column 10 and the inert gas tension in column 11. CNTR is automatically incremented in line 119 each time the recording procedure is executed.

Printout Procedure
(Lines 135 - 139)

The tissue inert gas tensions, zero time and gas tensions are written out to the line printer. The tissue halftimes and saturation desaturation ratios are written in a label for the appropriate tissue tension column. Figures 10, 11 and 12 show examples of Model Profile Parameter Output for the profiles in Fig. 4 and 5. In these cases, 9 tissues were specified so there are 9 columns of tissue tensions. If less than 9 tissues had been specified, zeros would have appeared in columns where a tissue was not specified. Column 10 is the Zero Time and keys the 9 tissue tensions to the rows having corresponding zero times in the profiles of Fig. 4 and 5. Tissue tensions are printed in the last column but are unlabeled. Figure 13 is the Model Profile Parameter Output for the multiple depth dive profile shown in Figure 6.

The array TT can hold up to 100 profile subsegments or 50 profile segments; in this case, the same number as the dive profile arrays in Program DMDB7.

Subroutine RDIN7

This subroutine reads in the data in the Model Iput Parameter File. A complete listing is found in Annex B-10. Since different computer operating systems handle disk files in different manners this subroutine must be tailored not only to the Decompression Model used but to the operating system as well. All subroutines except one which is used by this subroutine are part of the Hewlett-Packard RTE IV-B Operating System and will not be discussed. Subroutine FMPER is a subroutine which was especially written to decode any error messages which may occur when manipulating disk files and a listing is given for completeness in Annex D. No detailed description of Subroutine FMPER is given, the comments contained in the subroutine should be sufficient for those familiar with the RTE IV-B Operating System. Subroutine FMPER is not necessary for proper execution of Subroutine RDIN7 and can be left out. Its only purpose is to print out any errors which occurred during disk file manipulation as soon as it occurs. Without this subroutine the program would simply stop if an error occurred and the operating system would have to be interrogated to find the reason.

Model Parameter Input Files

A typical Model Parameter Input File (MPIF) which is read by Subroutine RDIN7 is shown in Figures 14 and 15. This particular file consists of 3 sub-files each 33 lines long. There is no limit to the number of sub-files which may be contained in each MPIF, however, each sub-file must be exactly 33 lines long and conform to the format in Figures 14 and 15.

PROFILE 1

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM          >

 150/ND
```

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	28.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
126.66023	96.50586	60.23941	48.77090	37.32841	33.22978	31.12218	29.84151	28.97762	14.05	1.00
119.99036	95.41780	69.23573	49.94891	38.14677	33.83263	31.59630	30.23172	29.30797	16.39	1.00
119.99036	95.41780	69.23573	49.94891	38.14677	33.83263	31.59630	30.23172	29.30797	16.39	1.00
119.29259	95.06900	69.06129	49.86169	38.10321	33.80516	31.57593	30.21721	29.29602	16.55	1.00

PROFILE 2

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM          >

 150/30
```

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	28.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
146.10617	131.20619	102.31900	72.85109	51.67581	43.37380	38.95785	36.22190	34.35783	30.00	1.00
130.98517	128.39618	101.89075	73.40414	52.30460	43.88929	39.38361	36.58182	34.66662	32.00	1.00
126.19281	122.00000	98.69266	71.80510	51.68267	43.62006	39.24049	36.49669	34.61244	35.06	1.00
125.49504	121.65112	98.51822	71.71788	51.64269	43.60088	39.22975	36.48908	34.60733	35.22	1.00
99.42216	108.61469	92.00000	68.45877	50.01314	42.71399	38.67796	36.10497	34.32021	41.45	1.00
98.72440	108.26581	91.82556	68.37155	49.96953	42.68719	38.66040	36.09181	34.31043	41.62	1.00
51.42215	84.61469	80.00000	62.45877	47.01314	40.71627	37.21970	35.03227	33.48180	52.92	1.00
50.72438	84.26581	79.82556	62.37155	46.96953	40.68719	37.19872	35.01502	33.46687	53.08	1.00

FIGURE 10. MODEL PROFILE PARAMETER PRINTOUTS AS PRINTED BY SUBROUTINE RCRD7 FOR THE FIRST TWO PROFILES IN FIGURE 4.

PROFILE 3

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57030	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	20.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
146.10617	131.20619	102.31900	72.85109	51.67581	43.37380	38.95785	36.22190	34.35783	30.00	1.00
136.89105	127.34953	101.36742	73.14249	52.17707	43.81301	39.33125	36.54446	34.63859	32.50	1.00

PROFILE 4

```
1:14 PM  TUE.,  5  JAN., 1982
 PROGRAM DMDB7 USING 10 FSW STOPS
 HVAL09<HELIUM        >

 150/30
```

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	20.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
146.10617	131.20619	102.31900	72.85109	51.67581	43.37380	38.95785	36.22190	34.35783	30.00	1.00
130.90517	120.39610	101.89075	73.40414	52.30460	43.88929	39.38361	36.58182	34.66662	32.00	1.00
126.19201	122.00000	98.69266	71.80510	51.68267	43.62006	39.24049	36.49669	34.61244	35.06	1.00
125.49504	121.65112	98.51822	71.71788	51.64269	43.60088	39.22975	36.48908	34.60733	35.22	1.00
52.11292	84.96007	80.17268	62.54511	47.10025	41.18397	37.71396	35.42884	33.81224	52.75	1.00
51.41515	84.61119	79.99825	62.45789	47.05675	41.15768	37.69710	35.41607	33.80270	52.92	1.00
51.41515	84.61119	79.99825	62.45789	47.05675	41.15768	37.69710	35.41607	33.80270	52.92	1.00
50.71730	84.26231	79.82381	62.37067	47.01314	41.12860	37.67487	35.39830	33.78844	53.08	1.00

FIGURE 11. MODEL PROFILE PARAMETER PRINTOUTS AS PRINTED BY SUBROUTINE RCRD7 FOR THE LAST PROFILE IN FIGURE 4 AND THE FIRST PROFILE IN FIGURE 5.

PROFILE 5

1:14 PM TUE., 5 JAN., 1982
PROGRAM DMDB7 USING 10 FSW STOPS
HVAL09(HELIUM)

150/30

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	28.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
146.10617	131.28619	102.31900	72.85109	51.67581	43.37380	38.95785	36.22190	34.35783	30.00	1.00
130.98517	128.39618	101.89075	73.40414	52.30460	43.88929	39.38361	36.58182	34.66662	32.00	1.00
126.19281	122.00000	98.69266	71.80510	51.68267	43.62006	39.24049	36.49669	34.61244	35.06	1.00
125.49504	121.65112	98.51822	71.71788	51.64269	43.60088	39.22975	36.48908	34.60733	35.22	1.00
125.49504	121.65112	98.51822	71.71788	51.64269	43.60088	39.22975	36.48908	34.60733	35.22	79.00
125.49504	121.65112	98.51822	71.71788	51.64269	43.60088	39.22975	36.48908	34.60733	35.22	79.00
123.10547	120.49634	97.94083	71.42918	51.49834	43.56377	39.23959	36.51589	34.64052	37.22	79.00
123.10547	120.49634	97.94083	71.42918	51.49834	43.56377	39.23959	36.51589	34.64052	37.22	79.00
99.42216	108.61469	92.00000	68.45877	50.01314	43.20583	39.33600	36.78119	34.97111	57.80	79.00
99.25397	108.53058	91.95795	68.43774	50.00262	43.20017	39.33489	36.77913	34.97038	57.97	79.00
51.42218	84.61469	80.00000	62.45877	47.01314	41.20718	37.89685	36.02657	34.60078	113.35	79.00
51.30250	84.55484	79.97008	62.44381	47.00566	41.20219	37.89254	36.02379	34.59801	113.52	79.00

FIGURE 12. MODEL PROFILE PARAMETER PRINTOUTS AS PRINTED BY SUBROUTINE RCRD7 FOR THE LAST PROFILE IN FIGURE 5.

1:21 PM TUE., 5 JAN., 1982
PROGRAM DMDB7 USING 10 FSW STOPS
HVAL89(HELIUM)

150/30

5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR	TIME	GAS
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	79.00
24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	24.57000	0.00	1.00
40.16747	32.69971	28.72124	26.66817	25.62514	25.27556	25.09845	24.99445	24.92262	2.50	1.00
146.10617	131.28619	102.31900	72.85109	51.67581	43.37380	38.95785	36.22190	34.35783	30.00	1.00
141.07846	129.44284	102.41406	73.63254	52.34354	43.89097	39.37463	36.57076	34.65589	31.50	1.00
58.54177	60.31859	64.44475	63.85016	54.83935	48.16986	43.75233	40.68793	38.44957	91.50	1.00
59.55527	60.77069	64.60109	63.93386	54.92030	48.24330	43.81634	40.74426	38.49986	92.00	1.00
88.04774	85.03384	80.05046	73.89288	62.60651	54.64828	49.26210	45.46010	42.64965	122.00	1.00
89.09430	85.66600	80.45432	74.14880	62.78357	54.78956	49.37910	45.56010	42.73718	122.50	1.00
118.38513	116.44788	108.98859	96.32440	79.10255	67.93300	60.37647	55.00211	51.00298	162.50	1.00
113.19228	113.91504	107.87480	95.93491	79.05960	67.98514	60.46111	55.09608	51.10100	164.00	1.00
39.96883	72.04897	86.94176	85.46838	73.82634	64.49629	57.85649	53.31503	49.83250	184.00	1.00
39.90602	71.38127	86.59288	85.29395	73.74104	64.44824	57.82837	53.29856	49.82127	184.33	1.00
48.36572	51.36816	62.36649	70.83878	67.96350	61.91082	56.69149	52.82471	49.71161	214.33	1.00
47.35847	50.75134	61.92113	70.58621	67.84138	61.83725	56.64363	52.79147	49.68782	214.83	1.00
25.20154	34.07604	50.89764	65.07446	65.08551	60.00000	55.26569	51.68913	48.76920	225.37	1.00
24.93378	33.83956	50.72320	64.98724	65.04190	59.97092	55.24389	51.67168	48.75466	225.53	1.00
8.50121	8.71777	12.66881	30.45765	47.08552	48.00000	46.26569	44.48913	42.76920	294.16	1.00
8.38649	8.65769	12.61601	30.38047	47.04191	47.97092	46.24369	44.47169	42.75467	294.32	1.00
24.57000	24.56612	24.38322	25.34548	42.74786	45.10822	44.09686	42.75407	41.32332	414.32	79.00
24.57000	24.56612	24.38322	25.34548	42.74786	45.10822	44.09686	42.75407	41.32332	414.32	79.00
24.57000	24.56612	24.38322	25.34548	42.74786	45.10822	44.09686	42.75407	41.32332	414.32	1.00
54.76700	40.61243	32.68011	29.50644	44.36450	46.14[illegible]14	44.88953	43.40399	41.87558	417.66	1.00
198.46490	196.03302	177.77252	138.75180	106.85051	90.76889	80.05017	72.52290	66.79506	477.66	1.00
183.93613	188.91748	175.07788	138.95615	107.91647	91.85356	81.05084	73.42885	67.61685	481.66	1.00
139.62460	166.76172	164.00000	133.41721	105.33887	91.06163	80.93652	73.61150	67.94449	492.24	1.00
138.22906	166.06396	163.65112	133.24277	105.25317	91.02788	80.92589	73.61098	67.95000	492.57	1.00
92.39229	142.76172	152.00000	127.41721	102.34039	89.62494	80.34088	73.41756	67.96739	503.71	1.00
91.10124	142.06396	151.65112	127.24277	102.25317	89.57504	80.31668	73.40579	67.96291	504.04	1.00
65.48775	118.76172	140.00000	121.41721	99.34039	87.65182	79.28955	72.84169	67.66351	515.17	1.00
64.94461	118.06395	139.65112	121.24277	99.25317	87.59348	79.25217	72.81905	67.65005	515.50	1.00
48.50000	48.52715	52.05093	63.94216	69.56771	68.77080	66.76836	64.54460	62.04113	635.50	1.00
68.42191	59.23326	57.22395	65.90915	70.41809	69.34079	67.24524	64.93604	62.39282	638.84	1.00
148.48047	147.10522	137.09052	119.29974	102.07224	92.52602	85.84404	80.62497	76.09277	698.84	1.00
142.58319	144.19928	135.84680	118.93590	102.05965	92.59053	85.93512	80.72937	76.19774	700.50	1.00
111.19598	128.50568	128.00000	115.01250	100.09795	91.28273	84.95427	79.94469	75.60446	708.00	1.00
110.49821	128.15680	127.82556	114.92528	100.05434	91.25366	84.93246	79.92725	75.58910	708.17	1.00
38.87810	50.61398	84.30360	93.16429	89.17384	84.00000	79.49222	75.57504	71.96227	749.75	1.00
38.75477	50.41727	84.12917	93.07707	89.13023	83.97093	79.47041	75.55760	71.94772	749.92	1.00
28.50000	28.50535	29.59525	40.28366	57.74606	63.03789	63.77063	62.99778	61.48120	869.92	1.00
28.27242	28.39054	29.52509	40.18700	57.65890	62.97974	63.72702	62.96289	61.45213	870.25	1.00
18.55134	19.21688	21.46821	29.75267	47.76641	56.37492	58.77341	59.00000	58.14972	908.11	1.00
18.32144	19.08581	21.37654	29.65907	47.67936	56.31678	58.72980	58.96511	58.12064	908.45	1.00
8.50000	8.50131	8.64329	10.73208	21.70512	34.07123	41.74884	45.38034	46.80000	1038.24	1.00
8.27242	8.38659	8.58407	10.69043	21.65249	34.01524	41.70523	45.34545	46.77093	1038.57	1.00

FIGURE 13. MODEL PROFILE PARAMETER PRINTOUT AS PRINTED BY SUBROUTINE RCRD7 FOR THE PROFILE IN FIGURE 6.

```
HVAL09 T=00004 IS ON CR00060 USING 00029 BLKS R=0000

 120.000  98.000  80.000  68.000  56.000  48.000  47.500  47.000  46.800
 132.000 110.000  92.000  80.000  68.000  60.000  59.500  59.000  58.800
 144.000 122.000 104.000  92.000  80.000  72.000  71.500  71.000  70.800
 156.000 134.000 116.000 104.000  92.000  84.000  83.500  83.000  82.800
 168.000 146.000 128.000 116.000 104.000  96.000  95.500  95.000  94.800
 180.000 158.000 140.000 128.000 116.000 108.000 107.500 107.000 106.800
 192.000 170.000 152.000 140.000 128.000 120.000 119.500 119.000 118.800
 204.000 182.000 164.000 152.000 140.000 132.000 131.500 131.000 130.800
 216.000 194.000 176.000 164.000 152.000 144.000 143.500 143.000 142.800
 228.000 206.000 188.000 176.000 164.000 156.000 155.500 155.000 154.800
 240.000 218.000 200.000 188.000 176.000 168.000 167.500 167.000 166.800
 252.000 230.000 212.000 200.000 188.000 180.000 179.500 179.000 178.800
 264.000 242.000 224.000 212.000 200.000 192.000 191.500 191.000 190.800
 276.000 254.000 236.000 224.000 212.000 204.000 203.500 203.000 202.800
 288.000 266.000 248.000 236.000 224.000 216.000 215.500 215.000 214.800
 300.000 278.000 260.000 248.000 236.000 228.000 227.500 227.000 226.800
 312.000 290.000 272.000 260.000 248.000 240.000 239.500 239.000 238.800
 324.000 302.000 284.000 272.000 260.000 252.000 251.500 251.000 250.800
 336.000 314.000 296.000 284.000 272.000 264.000 263.500 263.000 262.800
 348.000 326.000 308.000 296.000 284.000 276.000 275.500 275.000 274.800
 360.000 338.000 320.000 308.000 296.000 288.000 287.500 287.000 286.800
 372.000 350.000 332.000 320.000 308.000 300.000 299.500 299.000 298.800
 384.000 362.000 344.000 332.000 320.000 312.000 311.500 311.000 310.800
 396.000 374.000 356.000 344.000 332.000 324.000 323.500 323.000 322.800
 408.000 386.000 368.000 356.000 344.000 336.000 335.500 335.000 334.800
 420.000 398.000 380.000 368.000 356.000 348.000 347.500 347.000 346.800
 432.000 410.000 392.000 380.000 368.000 360.000 359.500 359.000 358.800
 444.000 422.000 404.000 392.000 380.000 372.000 371.500 371.000 370.800
 456.000 434.000 416.000 404.000 392.000 384.000 383.500 383.000 382.800
 468.000 446.000 428.000 416.000 404.000 396.000 395.500 395.000 394.800
       1       10HELIUM
   5.00   10.00   20.00   40.00   80.00  120.00  160.00  200.00  240.00         9
   1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00         9
 120.000  98.000  80.000  68.000  56.000  48.000  47.500  47.000  46.800
 131.811 109.911  91.811  79.911  67.911  59.911  59.311  58.911  58.611
 143.622 121.622 103.622  91.622  79.622  71.622  71.122  70.622  70.422
 155.433 133.433 115.433 103.433  91.433  83.433  82.933  82.433  82.233
 167.244 145.244 127.244 115.244 103.244  95.244  94.744  94.244  94.044
 179.055 157.055 139.055 127.055 115.055 107.055 106.555 106.055 105.855
 190.866 168.866 150.866 138.866 126.866 118.866 118.366 117.866 117.666
 202.677 180.677 162.677 150.677 138.677 130.677 130.177 129.677 129.477
 214.488 192.488 174.488 162.488 150.488 142.488 141.988 141.488 141.288
 226.299 204.299 186.299 174.299 162.299 154.299 153.799 153.299 153.099
 238.110 216.110 198.110 186.110 174.110 166.110 165.610 165.110 164.910
 249.921 227.921 209.921 197.921 185.921 177.921 177.421 176.921 176.721
 261.732 239.732 221.732 209.732 197.732 189.732 189.232 188.732 188.532
 273.543 251.543 233.543 221.543 209.543 201.543 201.043 200.543 200.343
 285.354 263.354 245.354 233.354 221.354 213.354 212.854 212.354 212.154
 297.166 275.165 257.165 245.165 233.165 225.165 224.665 224.165 223.965
 308.977 286.977 268.977 256.976 244.976 236.976 236.476 235.976 235.776
 320.788 298.788 280.788 268.787 256.787 248.788 248.288 247.788 247.588
 332.599 310.599 292.599 280.599 268.599 260.599 260.099 259.599 259.399
 344.410 322.410 304.410 292.410 280.410 272.410 271.910 271.410 271.210
 356.221 334.221 316.221 304.221 292.221 284.221 283.721 283.221 283.021
 368.032 346.032 328.032 316.032 304.032 296.032 295.532 295.032 294.832
 379.843 357.843 339.843 327.843 315.843 307.843 307.343 306.843 306.643
 391.654 369.654 351.654 339.654 327.654 319.654 319.154 318.654 318.454
 403.465 381.465 363.465 351.465 339.465 331.465 330.965 330.465 330.265
 415.276 393.276 375.276 363.276 351.276 343.276 342.776 342.276 342.076
 427.087 405.087 387.087 375.087 363.087 355.087 354.587 354.087 353.887
 438.898 416.898 398.898 386.898 374.898 366.898 366.398 365.898 365.698
 450.709 428.709 410.709 398.709 386.709 378.709 378.209 377.709 377.509
 462.520 440.520 422.520 410.520 398.520 390.520 390.020 389.520 389.320
       2        3HELIUM
   5.00   10.00   20.00   40.00   80.00  120.00  160.00  200.00  240.00         9
   1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00         9
```

FIGURE 14. THE FIRST TWO SUBFILES OF MODEL PARAMETER INPUT FILE HVAL09 THE LINE NUMBERS ON THE LEFT ARE FOR REFERENCE AND ARE NOT PART OF THE FILE

```
0067    120.000  98.000  80.000  68.000  56.000  48.000  47.500  47.000  46.800
0068    139.685 117.685  99.685  87.685  75.685  67.685  67.185  66.685  66.485
0069    159.370 137.370 119.370 107.370  95.370  87.370  86.870  86.370  86.170
0070    179.055 157.055 139.055 127.055 115.055 107.055 106.555 106.055 105.855
0071    198.740 176.740 158.740 146.740 134.740 126.740 126.240 125.740 125.540
0072    218.425 196.425 178.425 166.425 154.425 146.425 145.925 145.425 145.225
0073    238.110 216.110 198.110 186.110 174.110 166.110 165.610 165.110 164.910
0074    257.795 235.795 217.795 205.795 193.795 185.795 185.295 184.795 184.595
0075    277.480 255.480 237.480 225.480 213.480 205.480 204.980 204.480 204.280
0076    297.165 275.165 257.165 245.165 233.165 225.165 224.665 224.165 223.965
0077    316.850 294.850 276.850 264.850 252.850 244.850 244.350 243.850 243.650
0078    336.535 314.535 296.535 284.535 272.535 264.535 264.035 263.535 263.335
0079    356.221 334.220 316.220 304.220 292.220 284.220 283.720 283.220 283.020
0080    375.906 353.906 335.906 323.906 311.906 303.906 303.406 302.906 302.706
0081    395.591 373.591 355.591 343.591 331.591 323.591 323.091 322.591 322.391
0082    415.276 393.276 375.276 363.276 351.276 343.276 342.776 342.276 342.076
0083    434.961 412.961 394.961 382.961 370.961 362.961 362.461 361.961 361.761
0084    454.646 432.646 414.646 402.646 390.646 382.646 382.146 381.646 381.446
0085    474.331 452.331 434.331 422.331 410.331 402.331 401.831 401.331 401.131
0086    494.016 472.016 454.016 442.016 430.016 422.016 421.516 421.016 420.816
0087    513.701 491.701 473.701 461.701 449.701 441.701 441.201 440.701 440.501
0088    533.386 511.386 493.386 481.386 469.386 461.386 460.886 460.386 460.186
0089    553.071 531.071 513.071 501.071 489.071 481.071 480.571 480.071 479.871
0090    572.756 550.756 532.756 520.756 508.756 500.756 500.256 499.756 499.556
0091    592.441 570.441 552.441 540.441 528.441 520.441 519.941 519.441 519.241
0092    612.126 590.126 572.126 560.126 548.126 540.126 539.626 539.126 538.926
0093    631.811 609.811 591.811 579.811 567.811 559.811 559.311 558.811 558.611
0094    651.496 629.496 611.496 599.496 587.496 579.496 578.996 578.496 578.296
0095    671.181 649.181 631.181 619.181 607.181 599.181 598.681 598.181 597.981
0096    690.866 668.866 650.866 638.866 626.866 618.866 618.366 617.866 617.666
0097          2        SHELIUM
0098       5.00   10.00   20.00   40.00   80.00  120.00  160.00  200.00  240.00        9
0099       1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00    1.00        9
```

FIGURE 15. CONTINUATION OF THE MODEL PARAMETER INPUT FILE HVAL09 OF FIGURE 14 SHOWING THE THIRD SUBFILE. THE LINE NUMBERS ON THE LEFT ARE FOR REFERENCE AND ARE NOT PART OF THE FILE.

The first 30 lines of each sub-file are the maximum permissible tissue tensions in units of FSW (33 FSW = 1 ATA) in F8.3 format. Each column represents values for one halftime tissue and the tissue halftimes appear in the 32nd line in F7.2 format followed by the number of tissues in use in I9 format. If the number of tissues in use in less than 9 then only the left most tissues are used up to the maximum number by the MK 15/16 Decompression Model. Thus, if only 6 tissues are specified only the first 6 columns are meaningful. The sub-file must have numbers at all positions shown in Fig. 14. If certain tissues are not specified the values in the corresponding columns may be set to 0.0 or may contain any number since they will not be used. Subroutine RDIN7 always reads in all 9 columns of maximum permissible tissue tensions into array M, even if less than 9 tissues will be used.

The 31st line of each sub-file contains the Units Mode and Stop Depth Increment each in an I8 format followed by 12 alphanumeric characters which are the Inert Gas Label. Line 33 contains 9 Saturation-Desaturation Ratios in F7.2 format followed again by the number of tissues in I9 Format.

Subroutine RDIN7 will read the first 30 lines of each sub-file into array M then read the the next 3 lines of data into the appropriate variables. The subroutine then compares the Units Mode and Depth Increment in the 31st line with the values specified by the calling program. A Units Mode of "1" means that the Stop Depth Increment is in units of feet of seawater (FSW) and a "2" means it is in units of meters of seawater (MSW) (no matter what the Stop Depth Increment the maximum tissue tensions are always in FSW). If a match with the specified Units Mode and Stop Depth Increment is not made, the next 33 lines are read. Subroutine RDIN7 continues reading in 33 line sub-files until a sub-file with the specified Depth Units and Stop Depth Increments is encountered. There is no limit to the number of sub-files which may be contained in the MPIF, however, if no match of Units Mode or Stop Depth Increment is made by the time the end of the file is encountered, an error will occur and the program will stop.

The MK 15/16 Decompression Model MPIFs each contain 3 sub-files. The first is for Stop Depth Increments of 10 fSW, the second for Stop Depth Increments of 3 MSW and the third in increments of 5 MSW. Tissue halftimes, the number of tissues, Saturation Desaturation Ratios and the Inert Gas Label are identical for all 3 sub-files. The purpose of having 3 sub-files was to conveniently print out tables in either Imperial or Metric Units once an algorithm has been developed. The Inert Gas Label is used to label tables and profiles and indicates for what inert gas or combination of inert gases the maximum tissue tension values were developed.

The MPIF could be generated by a text editor but in the case of the MK 15/16 Decompression Model a program was used to generate these files. This program will be presented later.

File Read In Procedure
(Lines 141 - 202)

In lines 145 and 146 the value of IMODE is established depending on whether or not a metric stop depth increment is desired. The Stop Depth Increment desired by the calling program is integerized as IDINC in line 147.

In line 153-155 the desired file (IFILE) is opened. If an error occurs IERR returns as a negative number then Subroutine FMPER prints the error message and the subroutine causes an immediate halt. If Subroutine FMPER is not used Subroutine RDIN7 will function as described but no error messages will be printed.

The DO loop beginning at Statement 175 (line 161) reads in the first 30 rows of the MPIF into array M. In lines 170-184 the Depth Units Mode, Stop Depth Increment, Inert Gas Label, tissue halftimes, number of tissues and the Saturation-Desaturation Ratios are read in. In lines 190 and 191 control is transferred back to Statement 175 (line 161) if a match is not made between the Specified Depth Units Mode and Stop Depth Increments and the values actually read in.

Once a match is made the input file is closed in line 195 and if no printout is desired then the subroutine is exited at line 201.

Model Parameter Printout Procedure
(Lines 214 - 238)

This procedure prints out the values of IFILE, IGAS, arrays HLFTM, SDR, and M and the values in Common Block BLDVL in the format shown in Fig. 16.

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL09- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	98.000	80.000	68.000	56.000	48.000	47.500	47.000	46.800
20 FSW	132.000	110.000	92.000	80.000	68.000	60.000	59.500	59.000	58.800
30 FSW	144.000	122.000	104.000	92.000	80.000	72.000	71.500	71.000	70.800
40 FSW	156.000	134.000	116.000	104.000	92.000	84.000	83.500	83.000	82.800
50 FSW	168.000	146.000	128.000	116.000	104.000	96.000	95.500	95.000	94.800
60 FSW	180.000	158.000	140.000	128.000	116.000	108.000	107.500	107.000	106.800
70 FSW	192.000	170.000	152.000	140.000	128.000	120.000	119.500	119.000	118.800
80 FSW	204.000	182.000	164.000	152.000	140.000	132.000	131.500	131.000	130.800
90 FSW	216.000	194.000	176.000	164.000	152.000	144.000	143.500	143.000	142.800
100 FSW	228.000	206.000	188.000	176.000	164.000	156.000	155.500	155.000	154.800
110 FSW	240.000	218.000	200.000	188.000	176.000	168.000	167.500	167.000	166.800
120 FSW	252.000	230.000	212.000	200.000	188.000	180.000	179.500	179.000	178.800
130 FSW	264.000	242.000	224.000	212.000	200.000	192.000	191.500	191.000	190.800
140 FSW	276.000	254.000	236.000	224.000	212.000	204.000	203.500	203.000	202.800
150 FSW	288.000	266.000	248.000	236.000	224.000	216.000	215.500	215.000	214.800
160 FSW	300.000	278.000	260.000	248.000	236.000	228.000	227.500	227.000	226.800
170 FSW	312.000	290.000	272.000	260.000	248.000	240.000	239.500	239.000	238.800
180 FSW	324.000	302.000	284.000	272.000	260.000	252.000	251.500	251.000	250.800
190 FSW	336.000	314.000	296.000	284.000	272.000	264.000	263.500	263.000	262.800
200 FSW	348.000	326.000	308.000	296.000	284.000	276.000	275.500	275.000	274.800
210 FSW	360.000	338.000	320.000	308.000	296.000	288.000	287.500	287.000	286.800
220 FSW	372.000	350.000	332.000	320.000	308.000	300.000	299.500	299.000	298.800
230 FSW	384.000	362.000	344.000	332.000	320.000	312.000	311.500	311.000	310.800
240 FSW	396.000	374.000	356.000	344.000	332.000	324.000	323.500	323.000	322.800
250 FSW	408.000	386.000	368.000	356.000	344.000	336.000	335.500	335.000	334.800
260 FSW	420.000	398.000	380.000	368.000	356.000	348.000	347.500	347.000	346.800
270 FSW	432.000	410.000	392.000	380.000	368.000	360.000	359.500	359.000	358.800
280 FSW	444.000	422.000	404.000	392.000	380.000	372.000	371.500	371.000	370.800
290 FSW	456.000	434.000	416.000	404.000	392.000	384.000	383.500	383.000	382.800
300 FSW	468.000	446.000	428.000	416.000	404.000	396.000	395.500	395.000	394.800

BLOOD PARAMETERS

(PRESSURE IN FSW; 33 FSW=1 ATA)

PACO2	PH2O	PVCO2	PVO2	AMBAO2	PBOVP
1.50	0.00	2.30	2.00	0.00	0.000

FIGURE 16. HVALO9 ASCENT CRITERIA AS PRINTED OUT BY SUBROUTINE RDIN7. THE VALUES IN COMMON BLOCK BLDVL ARE ALSO PRINTED OUT BY THE SUBROUTINE.

PART 3

ASCENT CRITERIA

INTRODUCTION

The MK 15/16 Decompression Model described in Part 2 of this report is the algorithm for computing decompression tables. However, the decompression profiles may be varied by either changing the initialization values in Subroutine BLOC7 or by changing the ascent criteria in the Model Parameter Input File. As discussed during the description of Subroutine RDIN7, the Model Parameter Input File contains the ascent criteria (Maximum Permissible Tissue Tensions from the surface down to 30 stop depth increments), the units and magnitude of the Stop Depth Increment, an Inert Gas Label, up to nine tissue halftimes, the number of tissues and up to nine Saturation-Desaturation Ratios. Several different methods were used to compute the ascent criteria during the testing of the MK 15/16 Decompression Model. Program MVALU was used to generate the Model Parameter Input File containing the ascent criteria and Subroutine MCOMP is used by Program MVALU to actually compute the ascent criteria. Listings for Program MVALU and the three versions of Subroutine MCOMP used so far are given in Annex C. Version 1.0 of Subroutine MCOMP was used to generate the ascent criteria used in the current version of the Nitrogen/Oxygen and Helium/Oxygen Decompression Tables. Version 2.0 was used to generate the ascent criteria in MVAL 1, 2 and 3 and Version 2.1 to generate the ascent criteria in MVAL5. MVAL 1, 2, 3 and 5 were used to develop the first set of constant 0.7 ATA PO_2 in nitrogen decompression schedules as previously reported (1).

Program MVALU

This program allows creation of a new Model Parameter Input File, modification of existing files or listing of existing files. A listing of the program is found in Annex C-1. Figures 14 and 15 show the file format as it appears in mass storage. Three 33-line subfiles are expected but the program is capable of listing files containing only a single subfile as some of the early Model Parameter Input Files did. Both the input and output of files in Program MVALU is to a disk file.

Program MVALU uses Subroutine FMPER to print out errors which may occur during file manipulation. A listing of this subroutine is given in Annex D for completeness and it will not be discussed further. Subroutine MCOMP which actually computes the ascent criteria will be discussed later. All other subroutines used by Program MVALU are Hewlett Packard RTE IV-B Operating System Subroutines and will not be discussed here. Their functions are only briefly described in the program listing.

Initialization and Option Select Procedure
(Lines 145 - 175)

In lines 148-152 the device number of the terminal and line printer are established. Statement 40 (line 147) prints out a message asking for the desired option. Legal responses are "1", "2", or "6". Any other response will cause control to go back to Statement 40. Unless an error occurs, there

are only two ways to stop the program. That is by specifying option 6 at line 159 or 171. All normal exits from the program are from these two statements. Option 1 will produce only a listing of an existing file. If this option is selected control goes to Statement 50 (line 194) to get the file name and then Statement 53 (line 202) transfers control to the Printout Procedure beginning at line 465. Option 2 causes control to drop through to Statement 45 (line 168) where selection of one of three "Create" options is requested. If option "6" is selected, the program stops.

At line 168, a message is written to the terminal asking for one of 4 "Create" options. If one of the legal responses "3", "4", "5" or "6" is not selected, control goes back to Statement 45 where another option selection is requested. Option 3 will cause a new file to be created so no input file name is needed and line 172 transfers control to Statement 55 (line 211) to get an output file name. Option 4 will modify an existing file so the input and output file will be the same. Option 5 will need both an input file name and an output file name because it will use existing values in one file to create another. Both Options 4 and 5 cause control to go to Statement 50 to get the input file name. Note that Option 1 also ends up at Statement 50 from line 160.

Lines 194-198 ask for an input file name. Simply hitting a return will cause control to go back to Statement 40 if Option 1 had been initially selected and to Statement 45 if Option 4 or 5 had been selected to get a new option. Once an input file has been specified, line 202 will transfer control directly to the Printout Procedure if Option 1 had been selected. Option 4 requires no output file name since an existing file is being modified so line 206 causes the statements for getting the output file name to be skipped.

Lines 211-220 get the output file name and creates the output file for Options 3 and 5. If no file name is specified then control goes back to Statement 45 (line 168) to select a new option. If an error is encountered in line 218, IERR will be returned as a negative number and after the error message is printed by Subroutine FMPER, control will go back to Statement 55 (line 211) to get another output file name.

If Option 3 has been selected then lines 230-269 which read in data from an input file are skipped. Option 3 will start out with the variables set to the values in the DATA Statements at lines 92 and 96.

Options 4 and 5 will need to have the input file read in first. Statement 58 (line 230) opens the input file and if an error is encountered, control will go back to Statement 50 (line 194) to get a new input file name. Lines 237-240 read in the first row of the file, which are the surfacing Maximum Permissible Tissue Tensions (Surfacing Tensions), into array STNSN. Nine values are read, even if they are not all used. Lines 245-249 position the file to the 31st record to get the Units Mode, Stop Depth Increment and Inert Gas Label. Lines 254-257 read the tissue halftimes and number of tissues from the 32nd record and lines 262-265 read the Saturation-Desaturation Ratios from the 33rd record. Line 269 closes the input file.

Statement 65 (line 273) displays the data read in from the file on the terminal and if this is not what was wanted, typing any response but "YES" at line 278 will cause control to go back to Statement 45 (line 168) to select a new option. If "YES" is entered then the program proceeds to the Variable Change Procedure.

Variable Change Procedure
(Lines 295 - 335)

As currently written only the 1st, and 31st-33rd lines of the first subfile of the Model Parameter Input File are read in. All maximum permissible tissue tensions at depths below the surface are currently computed using only the first line of the first subfile as starting values.

Lines 298-327 allow changes to be made to the Inert Gas Label, Number of Tissues, Surfacing Tensions Tissue Halftime Values, Saturation-Desaturation Ratios and the Depth Multiplier (MULTP). (MULTP is used only by Version 1 of Subroutine MCOMP). Hitting a carriage return after any input is requested will retain the values originally displayed. In line 333 the user is asked if he is done. If more changes are desired or if the changes already made want to be reviewed, entering any response other than "YES" will transfer control back to Statement 70 (line 298). Once all changes are finished, entering a "YES" at line 334 will cause the program to drop through to compute the maximum permissible tissue tensions.

Maximum Permissible Tissue Tension Computation Procedure
(Lines 348 - 376)

The DO Loop beginning at line 351 will compute 3 sets of ascent criteria, in 10 FSW, 3 MSW and 5 MSW increments. The Surfacing Tensions are put in the first row of the Model Parameter Input File Array (MTABLE) in lines 352 and 353 and the proper value of the Stop Depth Increment and ATMD established in lines 359-375. The tissue tensions in array MTABLE are always in units of FSW but the Stop Depth Increments may be in FSW or MSW. ATMD has a value of either 1.0 or 3.28084 and when multiplied by INCR will always give a depth increment in FSW. Subroutine MCOMP is called to actually compute the table of maximum tissue tensions.

File Output Procedure
(Lines 388 - 454)

If option 4 has been selected an existing file will be replaced with a new one. In lines 392 to 396 the old file is eliminated by Subroutine PURGE and then a new file with the same name created. The input and output file

names are set equal to each other in lines 402 and 403 and the output file opened in line 402. If an error occurs control is transferred back to Statement 45 (line 168) where a new option may be specified.

Lines 412-453 write out the three subfiles contained in MTABLE to the output file in the format shown in Figures 14 and 15. Line 465 asks if a printout of the new files is wanted. If a "YES" is entered the file is rewound to the first record and control goes to Statement 175 (line 496) to print the file out. Any other response causes control to pass to Statement 165 (line 470) where the file is closed and control transferred back to the beginning of the program at Statement 40 (line 157) to select a new option.

Printout Procedure
(Lines 479 - 531)

Option 1 enters this procedure at Statement 170 (line 484) while all other options enter the procedure at Statement 175 (line 496). Lines 484-488 open the Option 1 file for input and sets the input file name equal to the output file name. An error on opening the file passes control to Statement 50 (line 194) to get a new input file name. Lines 496-530 read in one subfile at a time from the specified input file and prints each one out before reading the next one. This was done this way because some of the earlier Model Parameter Input Files had only one subfile which could then be read and printed before an end of file is encountered and the program stops. Since only a very few files had only one subfile it was not deemed necessary to detect and trap the error but just let the program stop.

Table 2 shows the format for the printout of the first subfile of the Model Parameter Input File MVAL0. The format is identical to that shown in Fig. 16 which was output by MK 15/16 Decompression Model Subroutine RDIN7 with the exception that the Blood Parameters which are not part of the Model Parameter Input File are not printed by Progam MVALU.

Subroutine MCOMP

There are 3 versions of this subroutine. Version 1.0 was used to compute the ascent criteria for the current version of the Nitrogen/Oxygen Decompression Tables and all versions of the Helium/Oxygen Decompression Tables. These tables will be described in forthcoming reports. Version 2.0 and 2.1 were used to compute the ascent criteria used for the Constant 0.7 ATA Oxygen Partial Pressure in Nitrogen Decompression Tables which have already been presented (1).

Version 1.0
(Annex C-2)

This version uses the first row of the Maximum Permissible Tissue Tension (Surfacing Tensions) as starting values and increments them linearly with increasing depth. The factor MULTP determines the rate of increase. The Surfacing Tensions and MULTP must be specified. ATMD will convert values of INCR given in meters to units of feet.

TABLE 2

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVALO - NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR
10 FSW	104.000	88.000	72.000	58.000	52.000	51.000
20 FSW	125.698	107.223	88.514	71.921	64.738	63.537
30 FSW	148.899	127.312	105.404	85.920	77.465	76.049
40 FSW	172.226	147.426	122.237	99.812	90.071	88.439
50 FSW	195.442	167.413	138.935	113.568	102.544	100.696
60 FSW	218.490	187.241	155.485	127.190	114.890	112.828
70 FSW	241.357	206.906	171.891	140.687	127.119	124.845
80 FSW	264.049	226.415	188.162	154.068	139.242	136.757
90 FSW	286.574	245.778	204.308	167.343	151.267	148.572
100 FSW	308.942	265.003	220.336	180.520	163.202	160.299
110 FSW	331.163	284.100	236.257	193.606	175.055	171.945
120 FSW	353.246	303.078	252.076	206.608	186.831	183.516
130 FSW	375.200	321.944	267.801	219.532	198.536	195.016
140 FSW	397.033	340.705	283.438	232.383	210.174	206.451
150 FSW	418.752	359.367	298.993	245.165	221.750	217.825
160 FSW	440.363	377.974	314.469	257.883	233.267	229.141
170 FSW	461.372	396.418	329.871	270.539	244.729	240.402
180 FSW	483.284	414.816	345.204	283.138	256.139	251.612
190 FSW	504.605	433.135	360.470	295.683	267.499	262.773
200 FSW	525.838	451.378	375.674	308.175	278.811	273.888
210 FSW	546.987	469.549	390.817	320.618	290.079	284.959
220 FSW	568.057	487.652	403.903	333.013	301.303	295.987
230 FSW	589.051	505.689	420.934	345.363	312.487	306.975
240 FSW	609.971	523.663	435.912	357.669	323.631	317.924
250 FSW	630.820	541.576	450.839	369.934	334.737	328.837
260 FSW	651.602	559.431	465.718	382.159	345.808	339.713
270 FSW	672.319	577.230	480.550	394.345	356.843	350.555
280 FSW	692.973	594.975	495.337	406.495	367.844	361.364
290 FSW	713.567	612.668	510.081	418.608	378.813	372.141
300 FSW	734.101	630.310	524.782	430.687	389.751	382.888

Version 2.0
(Annex C-3)

This version of Subroutine MCOMP was used to compute the ascent criteria in the Model Parameter Input Files MVAL1, MVAL2, and MVAL3 of reference (1). The relationship used to compute the maximum tensions shown in line 10 of Annex C-3 was originally presented by Dwyer in reference (2). There is one slight difference, however, in that Dwyer's calculation assumed 100% Nitrogen. The maximum tensions thus computed were later multiplied by 0.79 by Workman (3) to get his table of M-values (Appendix E of reference (3)) for computing air tables. The relationship presented here does this in one step. Table 2 shows the Table of Maximum Permissible Tissue Tensions computed by this version of MCOMP using the Surfacing Tensions as presented in Appendix E of reference (3). The agreement between Table 2 and Appendix E of reference (3) is quite good, the small differences probably being due to rounding errors done during the computation of the values in Appendix E of reference (3).

Program Description

Version 2.0 of Subroutine MCOMP uses a Newton-Raphson iteration to solve the equation given in line 10 for M and by setting IPRNT equal to " 1" in line 88 all iteration variables will be printed. In this case, IPRNT was set to "0" so iteration values will not be printed unless convergence does not occur in 10 iterations. The nitrogen fraction is set to .79 in line 92. The DO Loops beginning at lines 97 and 98 will compute maximum tensions for 9 compartments at 30 depth increments. The surfacing ratio is computed in line 107. The Newton-Raphson iteration from lines 114-174 is basically the same as discussed with Subroutine UPDT7 so its function will not be covered in detail here. T represents the trial maximum tensions and the initial estimate given in line 123 is simply the depth ratio of the previous maximum tension times the new nitrogen tension. The depth ratio R is computed at Statement 230 (line 124) which is where the iteration reenters with its successive estimates of T. The Newton-Raphson null variable Y is the difference between the right and left sides of the equation given in line 10 and DY is its first derivitive. After the iteration has finished, the appropriate element in MTABLE is set to the final value of T in line 174.

Version 2.1
(Annex C-4)

This version of MCOMP was used to compute the MVAL5 ascent criteria and the rationale behind the computation is given in reference (1). The computation is straight-forward, the Maximum Permissible Tissue Tension being given in Annex C-4 by line 57 for depths less than or equal to 80 FSW and by line 58 for depths greater than 80 FSW.

Ascent Criteria

Printouts of the ascent criteria for all the Model Parameter Input Files actually tested during development of the MK 15/16 Decompression Model are given in Annexes C-5, C-6 and C-7. The files used for schedule development using nitrogen as a diluent are MVAL 1, 2, and 3 (Annex C-6) and MVAL 5, 83, 92 and 94 (Annex C-7) which were all used with the E-E Version (Version 2) of Subroutines UPDT7 and STIM7, and VVAL09, 14 and 18 (Annex C-5) which were used with the E-L Version (Version 1) of these subroutines. All decompression schedules computed using the E-E Version of the Model had all values in Common Block BLDVL of Subroutine BLOC7 set to 0.0. The tables computed using the E-L Version used the values in Subroutine BLOC7 as presented in Annex B-1. MVAL 1, 2 and 3 were computed by Program MVALU using Version 2.0 of Subroutine MCOMP. MVAL5 was computed using Version 2.1 of Subroutine MCOMP. MVAL 83, 92, and 97 were constructed by modifying individual values in MVAL5 and cannot be directly computed from any set of initial assumptions.

All HVAL files (Annex C-5) and VVAL 09, 14 and 18 were created using Version 1.0 of Subroutine MCOMP. It should be noted that some of these files have the same Maximum Permissible Tissue Tensions and differ only in the number of tissues used and/or the Saturation-Desaturation Ratios.

Decompression Tables

To date, a complete set of Decompression Tables using MVAL5 have been published in reference (1). A complete set of tables using VVAL18 have been published in Chapter 16 of reference (4) which supercedes those computed using MVAL5 in reference (1). Reports describing tables computed with other sets of ascent criteria are forthcoming.

While one can compute any variety of tables using the computer programs described in this report, it must be again emphasized that the only conditions under which the MK 15/16 Decompression Model has been tested to date is using a constant PO_2 of 0.7 ATA in either a Nitrogen or Helium diluent. The E-L Model at present will not handle large changes in inspired oxygen tension which makes it unsuitable for computing air tables at present although this shortcoming is being worked out.

References

1. Thalmann, E.D. Testing of Decompression Algorithms for Use in The U.S. Navy Underwater Decompression Computer: Phase I. U.S. Navy Experimental Diving Unit Report 11-80.

2. Dwyer, J.V. Calculation of Repetitive Diving Decompression Tables. U.S. Navy Experimental Diving Unit Research Report 1-57.

3. Workman, R.D. Calculation of Decompression Schedules for Nitrogen-Oxygen and Helium-Oxygen Dives. U.S. Navy Experimental Diving Unit Research Report 6-65.

4. U.S. Navy Diving Manual, NAVSHIPS 0994-001-9010, Volume 2, Revision 1.

ANNEX A

MODEL INDEPENDENT
INPUT-OUTPUT
PROGRAM LISTINGS

ANNEX A-1

PROGRAM DMDB7
LISTING

```
&DMD87 T=00004 IS ON CR00012 USING 00079 BLKS R=0000

FTN4
      PROGRAM DMD87(3,99), 26 SEPT 82 VER 1.0
C
C
C     MODEL INDEPENDENT DECOMPRESSION PROFILE GENERATOR.
C     DECOMPRESSION MODEL WRITTEN IN 8 SUBROUTINES
C
C     ACCEPTS PROFILE COORDINATE INPUTS FROM A PROFILE COORDINATE INPUT
C     FILE AND PRINTS OUT A DECOMPRESSION PROFILE ON THE LINE PRINTER.
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                   @
C                   @             WRITTEN BY            @
C                   @                                   @
C                   @  CDR EDWARD D. THALMANN (MC) USN  @
C                   @                                   @
C                   @                                   @
C                   @   U.S. NAVY EXPERIMENTAL DIVING   @
C                   @               UNIT                @
C                   @   PANAMA CITY,FLORIDA      32407  @
C                   @                                   @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C*************************************************************************
C                                    *************
C                                    * VARIABLES *
C                                    *************
C
C             *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C                OPERATING SYSTEM
C
C     ATA             "ATA" LABEL
C     BTMTIM          DESCENT TIME INCLUDED IN "TIME"?
C     CDEPTH          CURRENT DEPTH (FSW OR MSW)
C     CF              METRIC CONVERSION FACTOR
C     CFSTOP          CALCULATE FIRST STOP?
C     CNTR            POSITION IN MODEL PARAMETER FILE
C     CPO2            CONSTANT PARTIAL PRESSURE O2?
C     CSTIME          COMPUTE STOP TIMES?
C     D               PROFILE DEPTH ARRAY
C    *DAYTIM          DATE-TIME ARRAY
C     DC              PROFILE SUB-SEGMENT DEPTH CHANGE (FSW OR MSW)
C     DEPTH           NEXT DEPTH (FSW OR MSW)
C     DFS             DEPTH OF FIRST STOP (FSW OR MSW)
C     DINC            STOP DEPTH INCREMENTS (FSW OR MSW)
C     DONE            DONE ENTERING CURRENT PROFILE?
C     FDEPTH          FINAL DEPTH FOR ASCENTS (FSW OR MSW)
C     FN2             CURRENT INERT GAS FRACTION IN USE
C     GAS             PROFILE INERT GAS TENSION ARRAY
C     GASLBL          LABELS GAS TENSION AS "%" OR "ATA"
C     GASTSN          GAS TENSION VALUE ARRAY
C     IGAS            INERT GAS(ES) NAME(S)
C    *IPAR            LOGICAL UNIT NUMBER ARRAY
C     IPRT            PRINT MODEL PARAMETER INPUT FILE?
C    *ISES            DUMMY VARIABLE
C     K               CURRENT POSITION IN DIVE PROFILE ARRAYS
C     LB              PROFILE COORDINATE INPUT FILE DEVICE NUMBER
C     LP              DEVICE NUMBER FOR LINE PRINTER
```

```
C      LSTOP          LAST STOP BEFORE SURFACING?
C      LU             DEVICE NUMBER FOR TERMINAL
C      METRIC         DEPTH AND RATE INPUTS IN METERS?
C      MORE           ANOTHER DIVE PROFILE TO FOLLOW?
C      MFIF           MODEL PARAMETER INPUT FILENAME
C      NGAS           GAS TENSION ARRAY SUBSCRIPT
C      NODLIM         COMPUTE NO-DECOMPRESSION LIMIT?
C      NODSTP         DON'T COMPUTE DECOMPERSSION STOPS ?
C      NOPRNT         MODEL PROFILE PARAMETER OUTPUT NOT WANTED?
C      OPTN           OPTION ARRAY
C      PERCNT         "%" LABEL
C      PO2            CURRENT OXYGEN PARTIAL PRESSURE (ATA)
C      PROID          PROFILE IDENTIFICATION LABEL
C      R              DIVE PROFILE RATE ARRAY
C      RATE           RATE OF CURRENT PROFILE SUB-SEGMENT (FSW OR MSW/MIN)
C      T              ELAPSED TIME DIVE PROFILE ARRAY
C      TC             TIME CHANGE OF CURRENT PROFILE SUB-SEGMENT (MIN)
C      TIME           TIME  AT CURRENT DEPTH (MIN)
C      UFEET          OUTPUT LABEL FOR PROFILES IN FEET
C      UMETER         OUTPUT LABEL FOR PROFILES IN METERS
C      UNITS          DEPTH UNITS SWITCH
C      ZT             DIVE PROFILE ZERO TIME ARRAY
C
C**********************************************************************
C
C**********************************************************************
C
C                           ************************
C                           * SUBROUTINES REQUIRED *
C                           ************************
C
C
C                              DECOMPRESSION MODEL
C
C                  BLOC7   INITIALIZES DATA IN COMMON BLOCK
C                  UPDT7   UPDATES MODEL OVER ONE PROFILE SUB-SEGMENT
C                  FRSP7   COMPUTES DEPTH OF FIRST STOP
C                  STIM7   COMPUTES STOP TIME AT A GIVEN DEPTH
C                  NLIM7   COMPUTES NO DECOMPRESSION TIME
C                  RCRD7   RECORDS OR OUTPUTS MODEL PARAMETERS
C                  RDIN7   READS IN MODEL PARAMETER INPUT FILE
C                  INIT7   INITIALIZES MODEL
C
C
C                                  PROGRAM
C
C                 * HEWLETT PACKARD RTE IV-B OPERATING SYSTEM SUBROUTINES
C                   AND FUNCTIONS
C
C                 *FTIME   GETS DATE AND TIME FROM COMPUTER
C                 *PMPAR   PASSES LOGICAL UNIT # OF TERMINAL TO PROGRAM
C                 *LOGLU   LOGICAL UNIT # OF TERMINAL
C                 *LUTRU   LOGICAL UNIT # OF TERMINAL ON ERROR
C
C**********************************************************************
C
C                     MODEL INPUT VARIABLES
C      THESE ARE THE ONLY VARIABLES SENT TO THE MODEL SUBROUTINES.
C      THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL SUBROUTINES.
C
```

```
      COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C
      LOGICAL CPO2,CFSTOP,CSTIME,DONE,LSTOP,METRIC,NODSTP,NODLIM,BTMTIM
      DOUBLE PRECISION UFEET,UMETER
      INTEGER CNTR,OPTN(4),UNITS,PROID(20),DAYTIM(15)
      REAL ZT(100),T(100),D(100),R(100),GAS(100),IGAS(3),GASLBL(100)
      DIMENSION GASTSN(2,4),IPAR(5),MPIF(3)
      DATA ATA,IGAS,IPRT,LP,LB/4H ATA,3*4H     ,0,6,9/
      DATA PERCNT,UFEET,UMETER/4H %   ,6HFEET   ,6HMETERS/
C
C
    1 FORMAT("1 "15A2)
    2 FORMAT(F11.2,F14.2,I10,I7,F8.2,A4)
    3 FORMAT(I4," FOOT INCREMENT")
    5 FORMAT(I4," METER INCREMENT")
    6 FORMAT(4X"ZERO TIME"3X"ELAPSED TIME"3X"DEPTH"3X"RATE"4X"GAS")
    9 FORMAT(/"PRINT MODEL INPUT PARAMETERS ?   (1-YES   2-NO) ")
   22 FORMAT(3A2)
   23 FORMAT(20A2)
   24 FORMAT(/4X,20A2/)
   25 FORMAT(A1,I1,3A2)
   26 FORMAT(4X,15A2"   DMDB7")
   41 FORMAT(4X,3A2,"("3A4")")
   42 FORMAT(4X"PROGRAM DMDB7 USING "I2" "A1"SW STOPS")
C
C*********************************************************************
C
C                      PROGRAM INITIALIZATION PROCEDURE
C
C*********************************************************************
C
C     GET TIME AND DATE FROM RTE IV-B OPERATING SYSTEM INTO "DAYTIM".
C
      CALL FTIME(DAYTIM)
C
C     ESTABLISH TERMINAL USED FOR PROGRAM CONTROL.
C
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LE.1)  LU=LUTRU(LU)
      IF(LU.LE.0)  LU=LOGLU(ISES)
C
C     READ IN MODEL PARAMETER INPUT FILENAME, DEPTH UNITS,AND STOP
C     DEPTH INCREMENT FROM PROFILE COORDINATE INPUT FILE DEVICE "LB".
C
      READ (LB,22) MPIF
      WRITE(LU,22) MPIF
      READ (LB,*) UNITS,DINC
C
C     IF "UNITS" NOT 1 THEN DEPTH INPUTS WILL BE IN METERS.
C
      METRIC=.FALSE.
      IF(UNITS.NE.1)  METRIC=.TRUE.
      IF(.NOT.METRIC)  WRITE(LU,3) DINC
      IF(METRIC)  WRITE(LU,5) DINC
C
C     "CF" CONVERTS METERS TO FEET FOR METRIC INPUTS.
C
      CF=1.0
```

```
      IF(METRIC)  CF=1.0/0.3048
C
C     ASK IF MODEL PARAMETER PRINTOUT WANTED. IF IT IS THEN "IPRT" WILL
C     BE 1 AND DATE,TIME PAGE HEADER PRINTED. RDIN7 RETURNS GAS LABEL
C     "IGAS" AFTER READING DATA FROM THE MODEL INPUT PARAMETER FILE.
C     RDIN7 WILL PRINTOUT MODEL INPUT PARAMETER FILE IF "IPRT" IS 1.
C
      WRITE(LU,9)
      READ(LU,*) IPRT
      IF(IPRT.EQ.1)  WRITE(LP,26) DAYTIM
      CALL RDIN7(LU,LP,MPIF,METRIC,IGAS,IPRT)
C
C
C*************************************************************************
C
C                        END PROGRAM INITIALIZATION PROCEDURE
C
C*************************************************************************
C
C
C*************************************************************************
C
C                       PROFILE INITIALIZATION PROCEDURE
C
C*************************************************************************
C
C     READ IN PROFILE IDENTIFIER.
C
200   READ(LB,23) PROID
C
C     READ IN INERT GAS FRACTIONS AND PARTIAL PRESSURES FROM THE
C     PROFILE COORDINATE INPUT DEVICE "LB"
C
      READ(LB,*) ((GASTSN(I,J),I=1,2),J=1,4)
C
C     INITIALIZE LOGICAL VARIABLES CONTROLLING FIRST STOP AND STOP TIME
C     PROCEDURES. SET COUNTERS TO 1.
C
      CFSTOP=.FALSE.
      CSTIME=.FALSE.
      CNTR=1
      K=1
C
C     READ IN INITIALIZATION DEPTH, FIRST NEW DEPTH, AND THE RATE
C     THEN SKIP OVER PROFILE COORDINATE INPUT AT STATEMENT #210.
C
      READ(LB,*) CDEPTH,DEPTH,RATE
      TIME=0.0
      GO TO 211
C
C*************************************************************************
C
C          END PROFILE INITIALIZATION PROCEDURE
C
C*************************************************************************
C
C
C*************************************************************************
C
C                    PROFILE GENERATION AND UPDATE LOOP
```

```
C
C               EXIT LOOP ONLY WHEN "DONE" BECOMES TRUE.
C
C*********************************************************************
C
C       READ IN PROFILE SEGMENT TIME,NEXT DEPTH AND RATE COORDINATES.
C
 210    READ(LB,*) TIME,DEPTH,RATE
C
C       GIVE "RATE" PROPER SIGN.
C
 211    RATE=ABS(RATE)
        IF(DEPTH.LT.CDEPTH)  RATE=-RATE
C
C       READ IN OPTIONS AND GAS TENSION SUBSCRIPT, INITIALIZE OPTIONS.
C
        READ(LB,25) OPTN(1),NGAS,(OPTN(I),I=2,4)
        NODSTP=.FALSE.
        LSTOP=.FALSE.
        DONE=.FALSE.
        BTMTIM=.FALSE.
        NODLIM=.FALSE.
C
C       FIRST OPTION MUST ALWAYS SPECIFY A GAS TENSION. IF NOT SKIP
C       EXECUTION OF OPTIONS.
C
        IF(OPTN(1).NE.1HF .AND. OPTN(1).NE.1HP)  GO TO 216
C
C       SET UP GAS TENSIONS SPECIFIED BY "OPTN(1)" AND "NGAS".
C
        IF(OPTN(1).EQ.1HP)  CPO2=.TRUE.
        IF(OPTN(1).EQ.1HF)  CPO2=.FALSE.
        IF(.NOT.CPO2)  FN2=GASTSN(1,NGAS)
        IF(CPO2)  PO2=GASTSN(2,NGAS)
C
C       EXECUTE REST OF OPTIONS.
C
        DO 214 I=2,4
        IF(OPTN(I).EQ.2HLS)  LSTOP=.TRUE.
        IF(OPTN(I).EQ.2HTX)  BTMTIM=.TRUE.
        IF(OPTN(I).EQ.2HND)  NODLIM=.TRUE.
        IF(OPTN(I).EQ.2HFN)  DONE=.TRUE.
        IF(OPTN(I).EQ.2HDX)  NODSTP=.TRUE.
 214    CONTINUE
C
C       INITIALIZE MODEL PARAMETERS FIRST TIME THROUGH.
C
 216    IF(K.EQ.1)  CALL INIT7
C
C       ASCENTS ALWAYS CAUSE CHECK TO SEE IF DECOMPRESSION STOPS NEEDED.
C       "CFSTOP" SET TO TRUE FOR ALL ASCENTS. IF "NODSTP" IS TRUE
C       DECOMPRESSION STOPS WILL NOT BE COMPUTED AND ASCENT WILL GO
C       DIRECTLY TO THE NEXT STOP WITHOUT ANY INTERVENING STOPS.
C
        IF(RATE.LT.0.0 .AND. .NOT.NODSTP)  CFSTOP=.TRUE.
C
C       IF "BTMTIM" IS TRUE THEN "TIME" INCLUDES DESCENT TIME. SUBTRACT
C       DESCENT TIME FROM "TIME". TIMES LESS THAN 0.0 NOT ALLOWED.
C
        IF(BTMTIM)  TIME=AMAX1((TIME-T(K-1)),0.0)
```

```
C
C     COMPUTE NO-DECOMPRESSION TIME IF "NODLIM" IS TRUE.
C
      IF(NODLIM)  CALL NLIM7(TIME)
C
C     RECORD PROFILE COORDINATES FOR THE FIRST SUB-SEGMENT.
C     STOP TIME COMPUTATION PROCEDURE REENTERS HERE.
C
220   D(K)=CDEPTH
      T(K)=TIME
      R(K)=RATE
      GAS(K)=FN2*100.
      GASLBL(K)=PERCNT
      IF(CPO2)  GAS(K)=PO2
      IF(CPO2)  GASLBL(K)=ATA
C
C     UPDATE MODEL PARAMETERS TO END OF FIRST SUB-SEGMENT,THEN RECORD.
C
      RATE=0.0
      DC=0.0
      TC=TIME
      CALL UPDT7
      CALL RCRD7(0,CNTR,LP)
C
C     IF ASCENDING ("CFSTOP" TRUE) BRANCH TO FIRST STOP DEPTH
C     COMPUTATION PROCEDURE. FIRST STOP PROCEDURE WILL SET "DEPTH" TO
C     THE DEPTH OF THE FIRST STOP AND SET "CSTIME" TO TRUE IF ANY STOPS
C     NEEDED. FIRST STOP PROCEDURE RETURNS TO NEXT STATEMENT (#230).
C     UPDATE "RATE" NOW BECAUSE FIRST STOP PROCEDURE NEEDS IT.
C
      RATE=R(K)
      IF(CFSTOP)  GO TO 300
C
C     UPDATE MODEL PARAMETERS TO END OF SECOND SUB-SEGMENT THEN RECORD.
C
230   DC=DEPTH-CDEPTH
      TC=DC/RATE
      CALL UPDT7
      CALL RCRD7(0,CNTR,LP)
C
C     RECORD PROFILE COORDINATES FOR SECOND SUB-SEGMENT.
C
      D(K+1)=DEPTH
      T(K+1)=TC
      R(K+1)=0.0
      GAS(K+1)=GAS(K)
      GASLBL(K+1)=GASLBL(K)
C
C     UPDATE POINTER "K" AND CURRENT DEPTH "CDEPTH" FOR NEXT SEGMENT.
C
      CDEPTH=DEPTH
      K=K+2
C
C     IF "CSTIME" IS TRUE BRANCH TO STOP TIME COMPUTATION PROCEDURE.
C     PROCEDURE CAUSES INPUT FROM PROFILE COORDINATE INPUT FILE TO
C     BE SKIPPED AND WILL RETURN TO STATEMENT 220. IF "LSTOP" IS TRUE
C     GO TO STOP TIME PROCEDURE TO COMPUTE LAST STOP TIME BEFORE
C     SURFACING.
C
      IF(CSTIME.OR.LSTOP)  GO TO 400
```

```
C
C     IF DONE GO TO OUTPUT PROCEDURE. IF NOT GO BACK TO BEGINNING OF
C     LOOP
C
      IF(DONE)  GO TO 500
      GO TO 210
C
C**********************************************************************
C
C           END OF PROFILE GENERATION AND UPDATE LOOP
C
C**********************************************************************
C
C
C**********************************************************************
C
C                  FIRST STOP DEPTH COMPUTATION PROCEDURE
C
C     IF STOPS REQUIRED BETWEEN CURRENT DEPTH AND NEXT DESIRED DEPTH
C     THIS PROCEDURE SETS "CSTIME" TO TRUE SO APPROPRIATE STOPS TIMES
C     AT PROPER DEPTH INCREMENTS WILL BE COMPUTED. THIS PROCEDURE
C     EXECUTES ONLY ONCE FOR EACH ASCENT.
C
C**********************************************************************
C
C     SET "FDEPTH" TO "DEPTH" AND COMPUTE DEPTH OF FIRST STOP (DFS).
C
300   CALL FRSP7(DFS)
      FDEPTH=DEPTH
C
C     IF DEPTH OF FIRST STOP (DFS) LESS THAN "DEPTH" NO STOPS NEEDED.
C     HOWEVER IF DEPTH IS 0.0 THERE IS ALWAYS A STOP AT "DINC" EVEN IF
C     IT IS 0.0 WHICH IT WILL BE FOR NO-DECOMPRESSION DIVES.
C
      IF(DFS.LE.DEPTH .AND. DEPTH.NE.0.0)  GO TO 360
C
C     SET "CSTIME" TRUE SO STOP TIMES WILL BE COMPUTED. SET DEPTH TO
C     FIRST STOP DEPTH (DFS) OR "DINC" WHICHEVER IS DEEPER.
C
      DEPTH=AMAX1(DFS,DINC)
      CSTIME=.TRUE.
C
C     SET "CFSTOP" TO FALSE SO WON'T COME BACK UNTIL THE NEXT ASCENT
C     OCCURS. THEN GO BACK TO PROFILE GENERATION AND UPDATE LOOP.
C
360   CFSTOP=.FALSE.
      GO TO 230
C
C**********************************************************************
C
C                           END FIRST STOP PROCEDURE
C
C**********************************************************************
C
C
C**********************************************************************
C
C                     STOP TIME COMPUTATION PROCEDURE
C
C     COMPUTES STOP TIMES AND THEN DECREMENTS DEPTH BY "DINC" UNTIL
```

```
C      NEXT DESIRED DEPTH (FDEPTH) REACHED. AS LONG AS "CSTIME" IS TRUE
C      THE INPUT FROM THE PROFILE COORDINATE INPUT FILE WILL BE SKIPPED.
C      WHEN "FDEPTH" IS REACHED HAVING TAKEN ALL NECESSARY DECOMPRESSION
C      STOPS THEN "CSTIME" IS SET TO FALSE. IF "LSTOP" IS TRUE THEN COME
C      BACK ONE MORE TIME TO COMPUTE THE LAST STOP TIME BEFORE SURFACING.
C
C              PROCEDURE ALWAYS RETURNS TO STATEMENT #220.
C
C*****************************************************************
C
C      IF WITHIN "DINC" OF "FDEPTH" A DIFFERENT PROCEDURE MUST BE USED.
C
400    IF((CDEPTH-FDEPTH).LE.DINC)  GO TO 410
C
C      "TIME" IS STOP TIME AT "CDEPTH" BEFORE ASCENDING "DINC".
C
       DEPTH=CDEPTH-DINC
       CALL STIM7(TIME,DEPTH)
C
C      RETURN TO PROFILE GENERATION AND UPDATE LOOP.
C
       GO TO 220
C
C      IF "CSTIME" TRUE WE'RE NOT AT "FDEPTH" YET.
C
410    IF(CSTIME)  GO TO 420
C
C      AT LAST DEPTH BEFORE SURFACING. SET "FDEPTH" TO THE SURFACE AND
C      COMPUTE LAST STOPTIME. DECREMENT DEPTH BY "DINC" AND SET "CSTIME"
C      TRUE SO MODEL PARAMETERS WILL BE RECORDED EVERY INCREMENT EVEN
C      THOUGH STOP TIMES WILL BE 0.0. "LSTOP" SET TO FALSE BECAUSE WE
C      DON'T WANT TO COME BACK AGAIN WHEN SURFACE REACHED.
C
       FDEPTH=0.0
       CALL STIM7(TIME,FDEPTH)
       DEPTH=CDEPTH-DINC
       CSTIME=.TRUE.
       LSTOP=.FALSE.
       GO TO 220
C
C      LAST STOP TIME COMPUTED. NEXT DEPTH IS "FDEPTH".
C
420    DEPTH=FDEPTH
       CALL STIM7(TIME,FDEPTH)
C
C      SET "CSTIME" TO FALSE SO WON'T COME BACK UNLESS "LSTOP" IS TRUE.
C
       CSTIME=.FALSE.
       GO TO 220
C
C*****************************************************************
C
C                        END STOP TIME PROCEDURE
C
C*****************************************************************
C
C
C*****************************************************************
C
C                     PROFILE OUTPUT PROCEDURE
```

```
C
C*********************************************************************************
C
C     COMPUTE ZERO TIME VALUES FROM ELAPSED TIME VALUES.
C
500   ZT(1)=0.0
      DO 510 I=2,K-1
510   ZT(I)=ZT(I-1)+T(I)
C
C     OUTPUT MODEL PROFILE PARAMETERS ? (YES OR NO)
C
      READ(LB,22) NOPRNT
C
C     OUTPUT DATE,TIME,AND STOP DEPTH INCREMENT HEADER.
C
      WRITE(LP,1) DAYTIM
      IF(.NOT.METRIC)  WRITE(LP,42) DINC,UFEET
      IF(METRIC)  WRITE(LP,42) DINC,UMETER
C
C     WRITE OUT PROFILE IDENTIFIER,MODEL PARAMETER INPUT FILENAME AND
C     INERT GAS NAME.
C
      WRITE(LP,41) MPIF,IGAS
      WRITE(LP,24) PROID
      WRITE(LP,6)
C
C     WRITE OUT DIVE PROFILE.
C
      DO 565 I=1,K-1
565   WRITE(LP,2) ZT(I),T(I),D(I),R(I),GAS(I),GASLBL(I)
C
C     IF MODEL PARAMETERS NOT WANTED SKIP REST OF OUTPUT ROUTINE.
C
      IF(NOPRNT.EQ.2HNO)  GO TO 575
C
C     OUTPUT DATE,TIME,AND STOP DEPTH INCREMENT HEADER.
C
      WRITE(LP,1) DAYTIM
      IF(.NOT.METRIC)  WRITE(LP,42) DINC,UFEET
      IF(METRIC)  WRITE(LP,42) DINC,UMETER
C
C     WRITE OUT PROFILE IDENTIFIER, MODEL PARAMETER INPUT FILENAME
C     AND INERT GAS(ES) NAME(S).
C
      WRITE(LP,41) MPIF,IGAS
      WRITE(LP,24) PROID
C
C     WRITE OUT MODEL PROFILE PARAMETERS.
C
      CALL RCRD7(1,CNTR,LP)
C
C     IF ANOTHER PROFILE FOLLOWS GO BACK TO PROFILE GENERATION AND
C     UPDATE LOOP. IF NOT,STOP PROGRAM AFTER FORM FEEDING LINE PRINER.
C
575   READ(LB,22) MORE
      IF(MORE.EQ.2HYE)  GO TO 200
      WRITE(LP,1)
      STOP
      END
      END$
```

ANNEX A-2

PROGRAM TBLP7
LISTING

```
&TBLP7 T=00004 IS ON CR00012 USING 00122 BLKS R=0000

FTN4
      PROGRAM TBLP7(3,99), 26 SEPT 82 VER 1.1
C
C
C     MODEL INDEPENDENT DECOMPRESSION TABLE COMPUTATUION PROGRAM.
C     DECOMPRESSION MODEL WRITTEN IN 7 SUBROUTINES
C
C     ACCEPTS PROFILE COORDINATE INPUTS FROM A PROFILE COORDINATE INPUT
C     FILE AND PRINTS OUT DECOMPRESSION TABLES IN U.S. NAVY FORMAT ON
C     THE LINE PRINTER.
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                       @
C                   @              WRITTEN BY               @
C                   @                                       @
C                   @   CDR EDWARD D. THALMANN (MC) USN     @
C                   @                                       @
C                   @                                       @
C                   @    U.S. NAVY EXPERIMENTAL DIVING      @
C                   @                 UNIT                  @
C                   @    PANAMA CITY,FLORIDA      32407     @
C                   @                                       @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*********************************************************************
C                                 *************
C                                 * VARIABLES *
C                                 *************
C
C            *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C               OPERATING SYSTEM
C
C     ASTIM          TOTAL TIME OF ASCENT (MIN)
C     BTMAX          MAXINUM PERMISSABLE BOTTOM TIME (MIN)
C     BTMTIM         DESCENT TIME INCLUDED IN "TIME"?
C     CDEPTH         CURRENT DEPTH (FSW OR MSW)
C     CF             METRIC CONVERSION FACTOR
C     CFSTOP         CALCULATE FIRST STOP?
C     CONC           OXYGEN TENSION FOR PRINTOUT
C     CONLBL         OXYGEN TENSION LABELS FOR PRINTOUT
C     CPO2           CONSTANT PARTIAL PRESSURE O2?
C     CSTIME         COMPUTE STOP TIMES?
C     D              PROFILE DEPTH ARRAY
C    *DAYTIM         DATE TIME ARRAY
C     DC             PROFILE SUB-SEGMENT DEPTH CHANGE (FSW OR MSW)
C     DEPTH          NEXT DEPTH (FSW OR MSW)
C     DFS            DEPTH OF FIRST STOP (FSW OR MSW)
C     DINC           STOP DEPTH INCREMENTS (FSW OR MSW)
C     DONE           DONE ENTERING CURRENT PROFILE?
C     DSTOPS         DEPTHS OF DECOMPRESSION STOPS (FSW OR MSW)
C     FDEPTH         FINAL DEPTH FOR ASCENTS (FSW OR MSW)
C     FN2            CURRENT INERT GAS FRACTION IN USE
C     FULBUF         "IPRO" BUFFER FULL?
C     GAS            PROFILE INERT GAS TENSION ARRAY
C     GASTSN         GAS TENSION VALUE ARRAY
```

```
C      ICHNG          BOTTOM DEPTH OF PROFILE GROUP BEING PRINTED
C      ICONC          POINTS TO PO2 OR FO2 LABELS IN "CONLBL"
C      IGAS           INERT GAS(ES) NAME(S)
C      ILBL           POINTS TO UNITS OR SPECIFICATION IN "CONLBL"
C     *IPAR           LOGICAL UNIT NUMBER ARRAY
C      IPRO           DECOMPRESSION PROFILE ARRAY
C      IPRT           PRINT MODEL PARAMETER INPUT FILE?
C      IRATE          RATE SPECIFIED ON FIRST PROFILE (FSW OR MSW/MIN)
C     *ISES           DUMMY VARIABLE
C      ISTOP          STOP DEPTH AT CURRENT "IPRO" POSITION (FSW OR MSW)
C      K              CURRENT POSITION IN DIVE PROFILE ARRAYS
C      LB             PROFILE COORDINATE INPUT FILE DEVICE NUMBER
C      LP             DEVICE NUMBER FOR LINE PRINTER
C      LSTOP          LAST STOP BEFORE SURFACING?
C      LU             DEVICE NUMBER FOR TERMINAL
C      MAXPRO         MAXIMUM NUMBER OF PROFILES PER PAGE.
C      METRIC         DEPTH AND RATE INPUTS IN METERS?
C      MORE           DO ANOTHER DIVE PROFILE?
C      MPIF           MODEL PARAMETER INPUT FILENAME
C      NGAS           GAS TENSION ARRAY, "GASTSN", SUBSCRIPT
C      NLINE          POINTS TO PROPER STATEMENT NUMBER FOR PRINTOUT
C      NODLIM         COMPUTE NO-DECOMPRESSION LIMIT?
C      NODSTP         DON'T COMPUTE DECOMPERSSION STOPS ?
C      NORCRD         DON'T RECORD DIVE PROFILE ?
C      NPRO           NUMBER OF PROFILES RECORDED IN "IPRO".
C      NSTOP          MAXIMUM NUMBER OF STOPS ALLOWED BY PRINTOUT FORMAT
C      OPTN           OPTION ARRAY
C      PO2            CURRENT OXYGEN PARTIAL PRESSURE (ATA)
C      PROFL1         FIRST PROFILE TO BE READ IN?
C      PROID          PROFILE IDENTIFICATION LABEL
C      R              DIVE PROFILE RATE ARRAY
C      RATE           RATE OF CURRENT PROFILE SUB-SEGMENT (FSW OR MSW/MIN)
C      T              ELAPSED TIME DIVE PROFILE ARRAY
C      TC             TIME CHANGE OF CURRENT PROFILE SUB-SEGMENT (MIN)
C      TDTMAX         MAXIMUM PERMISSABLE TOTAL DIVE TIME (MIN)
C      TFS            ASCENT TIME TO FIRST STOP (MIN)
C      TIME           TIME  AT CURRENT DEPTH (MIN)
C      TMIN           WHOLE MINUTES PORTION OF TIMES
C      TSEC           WHOLE SECONDS PORTION OF TIMES
C      UFEET          FEET LABEL
C      ULBL           DEPTH UNITS LABEL FOR PRINTOUT
C      UMETER         METERS LABEL
C      UNITS          DEPTH UNITS INDICATOR (1=FSW,2=MSW)
C      ZT             DIVE PROFILE ZERO TIME ARRAY
C
C**********************************************************************
C
C**********************************************************************
C
C                               ***********************
C                               * SUBROUTINES REQUIRED *
C                               ***********************
C
C
C                                  DECOMPRESSION MODEL
C
C                     BLOC7   INITIALIZES DATA IN COMMON BLOCK
C                     UPDT7   UPDATES MODEL OVER ONE PROFILE SUB-SEGMENT
C                     FRSP7   COMPUTES DEPTH OF FIRST STOP
C                     STIM7   COMPUTES STOP TIME AT A GIVEN DEPTH
```

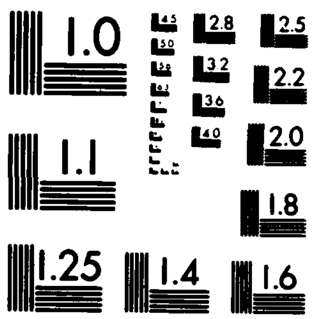
```
C               NLIM7   COMPUTES NO DECOMPRESSION TIME
C               RDIN7   READS IN MODEL PARAMETER INPUT FILE
C               INIT7   INITIALIZES MODEL
C
C
C                                 PROGRAM
C
C             * HEWLETT PACKARD RTE IV-B OPERATING SYSTEM SUBROUTINES
C               AND FUNCTIONS.
C
C             *FTIME    GETS DATE AND TIME FROM COMPUTER
C             *RMPAR    PASSES LOGICAL UNIT # OF TERMINAL TO PROGRAM
C             *LOGLU    LOGICAL UNIT # OF TERMINAL
C             *LUTRU    LOGICAL UNIT # OF TERMINAL ON ERROR
C
C**********************************************************************
C
C                          MODEL INPUT PARAMETERS
C     THIS IS THE ONLY DATA TRANSFERRED TO THE MODEL SUBROUTINES.
C     THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL SUBROUTINES.
C
      COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C
      LOGICAL CPO2,CFSTOP,CSTIME,DONE,LSTOP,METRIC,NODSTP,PROFL1,FULBUF
      LOGICAL NODLIM,BTMTIM,NORCRD
      DOUBLE PRECISION UFEET,UMETER,ULBL
      INTEGER IPAR(5),MPIF(3),PROID(20),DAYTIM(15)
      INTEGER DSTOPS(15),IPRO(24,26),OPTN(4),UNITS
      REAL ZT(100),T(100),D(100),R(100),GAS(100),IGAS(3)
      REAL CONLBL(2,2),GASTSN(2,4)
      DATA CONLBL,DSTOPS/4H ATA,4H%   ,4H PO2,4H FO2,15*0/
      DATA IGAS,IPRO,IPRT,LB,LP,MAXPRO/3*4H    ,624*0,0,9,6,25/
      DATA NPRO,NSTOP,PROFL1,NORCRD/0,15,.TRUE.,.FALSE./
      DATA UFEET,UMETER/6HFEET  ,6HMETERS/
C
3     FORMAT(I4," FOOT INCREMENT")
5     FORMAT(I4," METER INCREMENT")
9     FORMAT(/"PRINT MODEL INPUT PARAMETERS ?   (1-YES   2-NO) ")
22    FORMAT(3A2)
25    FORMAT(A1,I1,3A2)
26    FORMAT(4X,15A2"    TBLP7")
42    FORMAT(" :"4X,15A2"    TBLP7    "3A2" ("A6")"/)
43    FORMAT(
     *" :"4X"DEPTH BTM TM TO"T39"DECOMPRESSION STOPS ("A1
     *"SW)"T83"TOTAL"/
     *" :"4X"("A1"SW) TIM FIRST"T43"STOP TIMES (MIN)"T83
     *"ASCNT"/T13          "(M) STOP"T83"TIME"/" :"6X,T17
     *"(M:S)"I3,14I4,2X,"(M:S)"/)
44    FORMAT(" :")
46    FORMAT(" :"6X,79"*")
47    FORMAT("1")
48    FORMAT(" :"6X,F4.2,A4" FIXED"A4" IN "3A4,3X"DESCENT RATE"I3,1X,A1
     *          "PM    ASCENT RATE"I3,1X,A1"PM"/)
50    FORMAT(" :"6X,I3,I4,I3,":",2I1,55X,  I4,I4,":",2I1)
51    FORMAT(" :"6X,I3,I4,I3,":",2I1,51X, 2I4,I4,":",2I1)
52    FORMAT(" :"6X,I3,I4,I3,":",2I1,47X, 3I4,I4,":",2I1)
53    FORMAT(" :"6X,I3,I4,I3,":",2I1,43X, 4I4,I4,":",2I1)
54    FORMAT(" :"6X,I3,I4,I3,":",2I1,39X, 5I4,I4,":",2I1)
55    FORMAT(" :"6X,I3,I4,I3,":",2I1,35X, 6I4,I4,":",2I1)
```

```
 56     FORMAT(" :"6X,I3,I4,I3,":",2I1,31X, 7I4,I4,":",2I1)
 57     FORMAT(" :"6X,I3,I4,I3,":",2I1,27X, 8I4,I4,":",2I1)
 58     FORMAT(" :"6X,I3,I4,I3,":",2I1,23X, 9I4,I4,":",2I1)
 59     FORMAT(" :"6X,I3,I4,I3,":",2I1,19X,10I4,I4,":",2I1)
 60     FORMAT(" :"6X,I3,I4,I3,":",2I1,15X,11I4,I4,":",2I1)
 61     FORMAT(" :"6X,I3,I4,I3,":",2I1,11X,12I4,I4,":",2I1)
 62     FORMAT(" :"6X,I3,I4,I3,":",2I1, 7X,13I4,I4,":",2I1)
 63     FORMAT(" :"6X,I3,I4,I3,":",2I1, 3X,14I4,I4,":",2I1)
 64     FORMAT(" :"6X,I3,I4,I3,":",2I1, I3,14I4,I4,":",2I1)
C
C*********************************************************************
C
C                      PROGRAM INITIALIZATION PROCEDURE
C
C*********************************************************************
C
C
C       GET TIME AND DATE FROM RTE IV-B OPERATING SYSTEM INTO "DAYTIM".
C
        CALL FTIME(DAYTIM)
C
C       ESTABLISH TERMINAL USED FOR PROGRAM CONTROL.
C
        CALL RMPAR(IPAR)
        LU=IPAR(1)
        IF(LU.LE.1)  LU=LUTRU(LU)
        IF(LU.LE.0)  LU=LOGLU(ISES)
C
C       READ IN MODEL PARAMETER INPUT FILE NAME, DEPTH UNITS, AND STOP
C       DEPTH INCREMENT FROM PROFILE COORDINATE INPUT FILE DEVICE "LB".
C
        READ (LB, 22) MPIF
        WRITE(LU, 22) MPIF
        READ (LB,*) UNITS,DINC
C
C       IF "UNITS" NOT 1 THEN DEPTH INPUT WILL BE IN METERS.
C
        METRIC=.FALSE.
        IF(UNITS.NE.1)  METRIC=.TRUE.
        IF(.NOT.METRIC)  WRITE(LU,3) DINC
        IF(METRIC)  WRITE(LU,5) DINC
C
C       "CF" CONVERTS METERS TO FEET FOR METRIC INPUTS.
C
        CF=1.0
        IF(METRIC)  CF=1.0/0.3048
C
C       ASK IF MODEL PARAMETER PRINTOUT WANTED. IF IT IS THEN "IPRT" WILL
C       BE 1 AND DATE,TIME PAGE HEADER PRINTED. RDIN7 RETURNS GAS LABEL
C       "IGAS" AFTER READING DATA FROM THE MODEL INPUT PARAMETER FILE.
C       RDIN7 WILL PRINTOUT MODEL INPUT PARAMETER FILE IF "IPRT" IS 1.
C
        WRITE(LU,9)
        READ(LU,*) IPRT
        IF(IPRT.EQ.1)  WRITE(LP,26) DAYTIM
        CALL RDIN7(LU,LP,MPIF,METRIC,IGAS,IPRT)
C
C       COMPUTE STOP DEPTHS FOR LATER TABLE PRINTOUTS.
C
        DSTOPS(1)=NSTOP*DINC
```

```
      DO 100 I=2,NSTOP
100   DSTOPS(I)=DSTOPS(I-1)-DINC
C
C     SET VALUES FOR MAXIMUM TOTAL DIVE AND BOTTOM TIMES.
C
      BTMAX=365.
      TDTMAX=180.0
C
C*************************************************************************
C
C                        END PROGRAM INITIALIZATION
C
C*************************************************************************
C
C
C*************************************************************************
C
C                     PROFILE INITIALIZATION PROCEDURE
C
C*************************************************************************
C
C      SKIP PROFILE IDENTIFIER, NOT NEEDED.
C
200   READ(LB)
C
C     READ IN INERT GAS FRACTIONS AND PARTIAL PRESSURES FROM THE PROFILE
C     COORDINATE INPUT DEVICE "LB" ON THE FIRST PROFILE ONLY. SPACE PAST
C     THIS INPUT ON ALL OTHER PROFILES. "PROFL1" SET TRUE IN DATA
C     STATEMENT.
C
      IF(PROFL1)  READ(LB,*) ((GASTSN(I,J),I=1,2),J=1,4)
      IF(.NOT.PROFL1)  READ(LB)
C
C     INITIALIZE LOGICAL VARIABLES CONTROLLING FIRST STOP AND STOP TIME
C     PROCEDURES. SET PROFILE ARRAY SUBSCRIPT TO 1.
C
      CFSTOP=.FALSE.
      CSTIME=.FALSE.
      K=1
C
C     READ IN INITIALIZATION DEPTH, FIRST NEW DEPTH, AND THE RATE THEN
C     SKIP OVER THE PROFILE COORDINATE INPUT AT STATEMENT #210. THE RATE
C     SPECIFIED HERE WILL BE USED FOR ALL SUBSEQUENT PROFILES. "PROFL1"
C     SET TO FALSE AND NO FURTHER RATES WILL BE ASSIGNED TO "IRATE"
C     UNLESS THE PROGRAM IS RESTARTED.
C
      READ(LB,*) CDEPTH,DEPTH,RATE
      TIME=0.0
      IF(PROFL1)  IRATE=RATE
      PROFL1=.FALSE.
      GO TO 211
C
C*************************************************************************
C
C           END PROFILE INITIALIZATION PROCEDURE
C
C*************************************************************************
C
C
C*************************************************************************
```

AD-A125 064 COMPUTER ALGORITHMS USED IN COMPUTING THE MK 15/16 CONSTANT 07 ATA OXYGEN..(U) NAVY EXPERIMENTAL DIVING UNIT PANAMA CITY FL E D THALMANN JAN 83 NEDU-1-83 2/3

UNCLASSIFIED F/G 6/19 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
C
C                 PROFILE GENERATION AND UPDATE LOOP
C
C               EXIT LOOP ONLY WHEN "DONE" BECOMES TRUE.
C
C**********************************************************************
C
C     READ TIME AND NEXT DEPTH COORDINATES ONLY, IGNORE RATE.
C
210   READ(LB,*) TIME,DEPTH
C
C     "RATE" ALWAYS SET TO "IRATE" WHICH WAS SPECIFIED IN FIRST PROFILE.
C
      RATE=IRATE
C
C     GIVE RATE PROPER SIGN.
C
211   RATE=ABS(RATE)
      IF(DEPTH.LT.CDEPTH)  RATE=-RATE
C
C     READ IN OPTIONS AND GAS TENSION ARRAY SUBSCRIPT.
C
      READ(LB,25) OPTN(1),NGAS,(OPTN(I),I=2,4)
C
C     INITIALIZE VARIABLES SET BY OPTIONS.
C
      NODSTP=.FALSE.
      LSTOP=.FALSE.
      DONE=.FALSE.
      BTMTIM=.FALSE.
      NODLIM=.FALSE.
C
C     FIRST OPTION MUST ALWAYS SPECIFY A GAS TENSION. IF IT DOESN'T THEN
C     SKIP EXECUTION OF OPTIONS.
C
      IF(OPTN(1).NE.1HP .AND. OPTN(1).NE.1HF)  GO TO 216
C
C     SET UP GAS TENSIONS SPECIFIED BY "OPTN(1)" AND "NGAS".
C
      IF(OPTN(1).EQ.1HP)  CPO2=.TRUE.
      IF(OPTN(1).EQ.1HF)  CPO2=.FALSE.
      IF(.NOT.CPO2)  FN2=GASTSN(1,NGAS)
      IF(CPO2)  PO2=GASTSN(2,NGAS)
C
C     EXECUTE REST OF OPTIONS.
C
      DO 214 I=1,4
      IF(OPTN(I).EQ.2HLS)  LSTOP=.TRUE.
      IF(OPTN(I).EQ.2HTX)  BTMTIM=.TRUE.
      IF(OPTN(I).EQ.2HND)  NODLIM=.TRUE.
      IF(OPTN(I).EQ.2HFN)  DONE=.TRUE.
      IF(OPTN(I).EQ.2HDX)  NODSTP=.TRUE.
214   CONTINUE
C
C     INITIALIZE MODEL PARAMETERS FIRST TIME THROUGH
C
216   IF(K.EQ.1)  CALL INIT7
C
C     ASCENTS ALWAYS CAUSE CHECK TO SEE IF DECOMPRESSION STOPS NEEDED.
C     "CFSTOP" SET TO TRUE FOR ALL ASCENTS. IF "NODSTP" IS TRUE
```

```
C      DECOMPRESSION STOPS WILL NOT BE COMPUTED AND ASCENT WILL GO
C      DIRECTLY TO THE NEXT DEPTH WITHOUT ANY INTERVENING STOPS.
C
       IF((RATE.LT.0.0).AND.(.NOT.NODSTP))  CFSTOP=.TRUE.
C
C      IF "BTMTIM" IS TRUE THEN "TIME" INCLUDES DESCENT TIME. SUBTRACT
C      DESCENT TIME FROM "TIME". TIMES LESS THAN 0.0 NOT ALLOWED.
C
       IF(BTMTIM)  TIME=AMAX1((TIME-T(K-1)),0.0)
C
C      COMPUTE NO-DECOMPRESSION TIME IF "NODLIM" IS TRUE. ADD NO-D TIME
C      (MINIMUM VALUE .99) TO DESCENT TIME, TRUNCATE AND SUBTRACT DESCENT
C      TIME (RESULT WILL NOT BE LESS THAN ROUNDED UP DESCENT TIME). THIS
C      ENSURES THAT BOTTOM TIME (SUM OF DESCENT TIME AND TIME AT DEPTH)
C      WILL ALWAYS BE IN WHOLE MINUTES. DON'T EXCEED MAXIMUM BOTTOM TIME.
C
       IF(.NOT.NODLIM)  GO TO 219
       CALL NLIM7(TIME)
       IF((TIME+T(K-1)).GT.BTMAX)  TIME=BTMAX-T(K-1)
       TIME=AINT(AMAX1(TIME,0.99)+T(K-1))-T(K-1)
C
C      ADD 0.001 TO "TIME" TO TAKE CARE OF POTENTIAL ROUNDOFF ERROR WHEN
C      THE DESCENT TIME AND TIME AT DEPTH ARE ADDED DURING ZERO TIME
C      COMPUTATION IN THE PROFILE RECORDING PROCEDURE.
C
219    TIME=TIME+0.001
C
C      RECORD PROFILE COORDINATES FOR FIRST SUB-SEGMENT.
C      STOP TIME COMPUTATION PROCEDURE REENTERS HERE.
C
220    D(K)=CDEPTH
       T(K)=TIME
       R(K)=RATE
C
C      UPDATE MODEL PARAMETERS TO END OF FIRST SUB-SEGMENT,THEN RECORD.
C
       RATE=0.0
       DC=0.0
       TC=TIME
       CALL UPDT7
C
C      IF ASCENDING ("CFSTOP" TRUE) BRANCH TO FIRST STOP DEPTH
C      COMPUTATION PROCEDURE. FIRST STOP PROCEDURE WILL SET "DEPTH" TO
C      THE DEPTH OF THE FIRST STOP AND SET "CSTIME" TO TRUE IF STOPS
C      NEEDED. FIRST STOP PROCEDURE RETURNS TO NEXT STATEMENT (#230).
C      UPDATE "RATE" NOW BECAUSE FIRST STOP PROCEDURE NEEDS IT.
C
       RATE=R(K)
       IF(CFSTOP)  GO TO 300
C
C      UPDATE MODEL PARAMETERS TO END OF SECOND SUB-SEGMENT THEN RECORD.
C
230    DC=DEPTH-CDEPTH
       TC=DC/RATE
       CALL UPDT7
C
C      RECORD PROFILE COORDINATES FOR SECOND SUB-SEGMENT.
C
       D(K+1)=DEPTH
       T(K+1)=TC
```

```
      R(K+1)=0.0
C
C     UPDATE POINTER "K" AND CURRENT DEPTH "CDEPTH" FOR NEXT SEGMENT.
C
      CDEPTH=DEPTH
      K=K+2
C
C     IF "CSTIME" IS TRUE BRANCH TO STOP TIME COMPUTATION PROCEDURE.
C     PROCEDURE CAUSES INPUT FROM PROFILE COORDINATE INPUT FILE TO
C     BE SKIPPED AND WILL RETURN TO STATEMENT #220. IF "LSTOP" IS
C     TRUE BRANCH TO COMPUTE LAST STOP TIME BEFORE SURFACING.
C
      IF(CSTIME.OR.LSTOP)  GO TO 400
C
C     IF DONE GO TO OUTPUT PROCEDURE. IF NOT GO TO BEGINNING OF LOOP.
C
      IF(DONE)  GO TO 500
      GO TO 210
C
C*********************************************************************
C
C          END OF PROFILE GENERATION AND UPDATE LOOP
C
C*********************************************************************
C
C
C*********************************************************************
C
C                FIRST STOP DEPTH COMPUTATION PROCEDURE
C
C     IF STOPS REQUIRED BETWEEN CURRENT DEPTH AND NEXT DESIRED DEPTH
C     THIS PROCEDURE SETS "CSTIME" TO TRUE SO APPROPRIATE STOPS TIMES
C     AT PROPER DEPTH INCREMENTS WILL BE COMPUTED. THIS PROCEDURE
C     EXECUTES ONLY ONCE FOR EACH ASCENT.
C
C*********************************************************************
C
C     SET "FDEPTH" TO "DEPTH" AND COMPUTE DEPTH OF FIRST STOP (DFS).
C
300   CALL FRSP7(DFS)
      FDEPTH=DEPTH
C
C     IF DEPTH OF FIRST STOP (DFS) LESS THAN "DEPTH" NO STOPS NEEDED.
C     HOWEVER IF DEPTH IS 0.0 THERE IS ALWAYS A STOP AT "DINC" EVEN IF
C     IT IS 0.0 WHICH IT WILL BE FOR NO-DECOMPRESSION DIVES.
C
      IF(DFS.LE.DEPTH .AND. DEPTH.NE.0.0)  GO TO 360
C
C     SET "CSTIME" TRUE SO STOP TIMES WILL BE COMPUTED. SET DEPTH TO
C     FIRST STOP DEPTH (DFS) OR "DINC" WHICHEVER IS DEEPER.
C
      DEPTH=AMAX1(DFS,DINC)
      CSTIME=.TRUE.
C
C     SET "CFSTOP" TO FALSE SO WON'T COME BACK UNTIL THE NEXT ASCENT
C     OCCURS. THEN GO BACK TO PROFILE GENERATION AND UPDATE LOOP.
C
360   CFSTOP=.FALSE.
      GO TO 230
C
```

```
C*********************************************************************
C
C                        END FIRST STOP PROCEDURE
C
C*********************************************************************
C
C
C*********************************************************************
C
C                  STOP TIME COMPUTATION PROCEDURE
C
C      COMPUTES STOP TIMES AND THEN DECREMENTS DEPTH BY "DINC" UNTIL
C      NEXT DESIRED DEPTH (FDEPTH) REACHED. AS LONG AS "CSTIME" IS TRUE
C      THE INPUT FROM THE PROFILE COORDINATE INPUT FILE WILL BE SKIPPED.
C      WHEN "FDEPTH" IS REACHED HAVING TAKEN ALL NECESSARY DECOMPRESSION
C      STOPS THEN "CSTIME" IS SET TO FALSE. IF "LSTOP" IS TRUE THEN COME
C      BACK ONE MORE TIME TO COMPUTE THE LAST STOP TIME BEFORE SURFACING.
C
C              PROCEDURE ALWAYS RETURNS TO STATEMENT #220
C
C*********************************************************************
C
C      IF WITHIN "DINC" OF "FDEPTH" A DIFFERENT PROCEDURE MUST BE USED.
C
400    IF((CDEPTH-FDEPTH).LE.DINC)  GO TO 410
C
C      "TIME" IS STOP TIME AT "CDEPTH" BEFORE ASCENDING "DINC". GO ROUND
C      OFF TIME BEFORE RETURNING TO PROFILE GENERATION AND UPDATE LOOP.
C
       DEPTH=CDEPTH-DINC
       CALL STIM7(TIME,DEPTH)
       GO TO 440
C
C      IF "CSTIME" TRUE THEN WE'RE NOT AT "FDEPTH" YET.
C
410    IF(CSTIME)  GO TO 420
C
C      AT LAST DEPTH BEFORE SURFACING. SET "FDEPTH" TO THE SURFACE AND
C      COMPUTE LAST STOP TIME, SET "LSTOP" TO FALSE SO WON'T COME BACK
C      AGAIN WHEN SURFACE REACHED. "CSTIME" SET TO TRUE SO 0.0 MIN STOP
C      TIMES WILL BE RECORDED FOR LATER OUTPUT. "DEPTH" DECREMENTED TO
C      NEXT SHALLOWER STOP DEPTH.
C
       FDEPTH=0.0
       CALL STIM7(TIME,FDEPTH)
       DEPTH=CDEPTH-DINC
       CSTIME=.TRUE.
       LSTOP=.FALSE.
       GO TO 440
C
C      LAST STOPTIME COMPUTED. LAST DEPTH IS "FDEPTH".
C
420    DEPTH=FDEPTH
       CALL STIM7(TIME,FDEPTH)
C
C      LAST TIME THROUGH, SET "CSTIME" TO FALSE SO WON'T COME BACK AGAIN.
C
       CSTIME=.FALSE.
C
C      ROUND UP STOP TIME TO NEAREST 0.9 MINUTES. MINIMUM TIME 1 MIN. FOR
```

```
C     NON-ZERO STOP TIMES.
C
440   IF(TIME.GT.0.0)  TIME=MAX1((TIME+0.9),1.0)
C
C     RETURN TO PROFILE GENERATION AND UPDATE LOOP.
C
      GO TO 220
C
C*****************************************************************
C
C                    END STOP TIME PROCEDURE
C
C*****************************************************************
C
C
C*****************************************************************
C
C                    PROFILE RECORDING PROCEDURE
C
C     RECORDS PROFILES IN ARRAY "IPRO" FOR LATER PRINTOUT IN U.S. NAVY
C     FORMAT. "IPRO" HOLDS "MAXPRO" PROFILES AND WHEN IT IS FULL THE
C     PROGRAM BRANCHES TO THE PRINTOUT PROCEDURE TO PRINT A PAGE OF
C     TABLES.
C
C*****************************************************************
C
C     IF FIRST STOP DEPTH GREATER THAN THAT ALLOWED BY OUTPUT FORMAT
C     RECORDING PROCEDURE.  IF NOT DECREMENT "K" TO GET TO LAST POSITION
C     RECORDED IN PROFILE ARRAY.
C
500   IF(INT(D(6)).GT.DSTOPS(1)) GO TO 560
      K=K-1
C
C     COMPUTE ZERO TIME VALUES FROM ELAPSED TIME VALUES.
C
      ZT(1)=0.0
      DO 510 I=2,K
510   ZT(I)=ZT(I-1)+T(I)
C
C     IF TOTAL DIVE TIME EXCEEDS MAXIMUM,  SET "NORCRD" TO TRUE. ALL
C     SUBSEQUENT PROFILES WHERE MAXIMUM TIME EXCEEDED WILL NOT BE
C     RECORDED.
C
      IF(ZT(K).LE.TDTMAX)  GO TO 513
      IF(NORCRD)  GO TO 560
      NORCRD=.TRUE.
      GO TO 515
513   NORCRD=.FALSE.
C
C     ALWAYS RECORD FIRST PROFILE COMPUTED BY THE PROGRAM (NPRO=0) AND
C     PROFILES WHERE THE DIVE DEPTH IS DIFFERENT FROM THE PREVIOUS ONE.
C
515   IF(NPRO.EQ.0)  GO TO 520
      IF(INT(D(5)).NE.IPRO(1,NPRO))  GO TO 520
C
C     DO NOT RECORD PROFILES IF THE BOTTOM TIME IS LESS THAN OR EQUAL TO
C     THAT OF THE PREVIOUSLY RECORDED PROFILE. OTHERWISE RECORD ALL
C     PROFILES REQUIRING DECOMPRESSION STOPS.
C
      IF(INT(ZT(5)).LE.IPRO(2,NPRO))  GO TO 560
```

```
      IF(D(7).GT.DINC .OR. T(7).NE.0.0) GO TO 520
C
C     OVERWRITE PREVIOUSLY RECORDED NO-D PROFILES UNTIL FIRST
C     DECOMPRESSION PROFILE ENCOUNTERED. DON'T INCREMENT "NPRO" YET.
C
      GO TO 540
C
C     EVERY RECORDED PROFILE INCREMENTS "NPRO" UNTIL "IPRO" FULL
C
520   NPRO=NPRO+1
C
C     COMPUTE ASCENT TIME (ASTIM), ROUND TO NEAREST SECOND, RECORD
C     MINUTES, TENS AND UNITS OF SECONDS SEPERATELY INTO ARRAY "IPRO".
C
540   ASTIM=ZT(K)-ZT(5)+(.5/60.)
      TMIN=INT(ASTIM)
      TSEC=(ASTIM-TMIN)*60.
      IPRO(NSTOP+6,NPRO)=TMIN
      IPRO(NSTOP+7,NPRO)=TSEC/10.0
      IPRO(NSTOP+8,NPRO)=INT(TSEC)-IPRO(NSTOP+7,NPRO)*10
C
C     COMPUTE TIME TO THE FIRST STOP (TFS) WHICH WILL EQUAL "ASTIM" FOR
C     NO-D DIVES. ROUND OFF AND RECORD THE SAME AS FOR "ASTIM" ABOVE.
C
      TFS=T(6)+(.5/60.)
      IF(INT(T(7)).EQ.0 .AND. D(6).EQ.DINC) TFS=ASTIM
      TMIN=INT(TFS)
      TSEC=(TFS-TMIN)*60.
      IPRO(3,NPRO)=TMIN
      IPRO(4,NPRO)=TSEC/10.
      IPRO(5,NPRO)=INT(TSEC)-IPRO(4,NPRO)*10
C
C     RECORD DEPTH OF DIVE AND BOTTOM TIME INTO "IPRO".
C
      IPRO(1,NPRO)=D(5)
      IPRO(2,NPRO)=ZT(5)
C
C     "IJ" POINTS TO POSITION OF THE FIRST STOP IN "IPRO" AND "D(6)" IS
C     THE DEPTH OF THE FIRST STOP.
C
      IJ=NSTOP+6-INT(D(6)/DINC)
C
C     THE NUMBER OF STOPS IS STORED IN THE LAST POSITION IN "IPRO".
C
      IPRO(NSTOP+9,NPRO)=INT(D(6)/DINC)
C
C     "ISTOP" INITIALLY SET TO DEPTH OF FIRST STOP IN PROFILE DEPTH
C     ARRAY "D". "NK" POINTS TO DEPTH OF STOP RECORDED IN ARRAY "IPRO".
C
      NK=6
      ISTOP=INT(D(6))
C
C     RECORD STOP TIMES INTO "IPRO". "NK+1" POINTS TO ARRAY POSITION
C     CONTAINING STOP TIME.
C
      DO 550 I=IJ,NSTOP+5
545   IPRO(I,NPRO)=IPRO(I,NPRO)+T(NK+1)
      NK=NK+2
C
C     IF THE NEXT RECORDED DEPTH IS STILL THE SAME AS "ISTOP" ADD THE
```

```
C      STOP TIME TO THE STOP TIME ALREADY RECORDED IN "IPRO".
C
       IF(INT(D(NK)).EQ.ISTOP)  GO TO 545
 550   ISTOP=ISTOP-DINC
C
C      SPACE PAST THE NEXT RECORD WHICH IS NOT NEEDED FOR THIS PROGRAM.
C      THIS MAINTAINS INPUT FILE COMPATIBILITY WITH PROGRAM DMDB7. READ
C      IN VALUE OF "MORE" (YES OR NO) TO SPECIFY IF ANOTHER PROFILE WILL
C      FOLLOW.
C
 560   READ(LB)
       READ(LB,22) MORE
C
C      IF "IPRO" BUFFER FULL SET "FULBUF" TO TRUE AND PRINTOUT A PAGE OF
C      TABLES BEFORE CONTINUING.
C
 570   FULBUF=.FALSE.
       IF(NPRO.EQ.(MAXPRO+1))  FULBUF=.TRUE.
       IF(FULBUF)  GO TO 580
C
C      IF ANOTHER PROFILE FOLLOWS GO BEGIN READING IT IN.
C
       IF(MORE.EQ.2HYE)  GO TO 200
C
C*********************************************************************
C
C                        END PROFILE RECORDING PROCEDURE
C
C*********************************************************************
C
C
C*********************************************************************
C
C                           TABLE PRINTOUT PROCEDURE
C
C      PRINTS OUT ONE PAGE OR A PARTIAL PAGE(LAST PAGE ONLY) OF TABLES
C
C*********************************************************************
C
C      VALUE OF "ICONC" DEPENDS ON WHETHER CONSTANT FRACTION OF INERT GAS
C      OR CONSTANT PO2 USED FOR TABLES AND GETS PROPER LABELS FROM THE
C      THE GAS LABEL ARRAY "CONLBL".
C
 580   CONC=PO2
       ICONC=1
       IF(CPO2)  GO TO 590
       CONC=(1-FN2)*100.
       ICONC=2
C
C      SET UP CORRECT LABELS FOR DEPTH UNITS (ULBL) FOR PRINTOUT.
C
 590   ULBL=UFEET
       IF(METRIC)  ULBL=UMETER
C
C      PRINTOUT PAGE HEADER
C
       WRITE(LP,42)  DAYTIM,MPIF,ULBL
       WRITE(LP,40)CONC,(CONLBL(ICONC,ILBL),ILBL=1,2),IGAS,IRATE,ULBL,
     *              IRATE,ULBL
       WRITE(LP,43) ULBL,ULBL,DSTOPS
```

```
C
C     "ICHNG" USED TO DETERMINE IF DEPTH OF PROFILES HAS CHANGED. IT'S
C     INITIALLY SET TO DEPTH OF FIRST PROFILE CURRENTLY IN "IPRO". THE
C     MAXIMUM VALUE OF "NPRO" FOR PRINTOUT IS ""MAXPRO".
C
      ICHNG=IPRO(1,1)
      IF(FULBUF)  NPRO=MAXPRO
C
C     BEGINNING OF LOOP WHICH PRINTS OUT PAGE OF PROFILES
C
      DO 670 I=1,NPRO
C
C     IF DEPTH OF PROFILE HASN'T CHANGED SKIP DELIMITER LINE PRINTOUT.
C
      IF(ICHNG.EQ.IPRO(1,I))  GO TO 630
C
C     RESET "ICHNG" TO NEXT PROFILE DEPTH. PRINT DELIMITER LINE.
C
      ICHNG=IPRO(1,I)
      WRITE(LP,46)
      GO TO 640
630   WRITE(LP,44)
C
C     "NLINE" SELECTS PROPER WRITE STATEMENT FOR NUMBER OF STOPS.
C     "IJ" POINTS TO POSITION OF FIRST STOP TIME IN "IPRO" ARRAY.
C
640   NLINE=IPRO(NSTOP+9,I)
      IJ=NSTOP+6-NLINE
      GO TO (650,651,652,653,654,655,656,657,658,659,660,661,
     *          662,663,664),NLINE
C
C     WRITE OUT A SINGLE PROFILE LINE IN THE CURRENT PAGE OF TABLES.
C
650   WRITE(LP,50) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
651   WRITE(LP,51) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
652   WRITE(LP,52) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
653   WRITE(LP,53) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
654   WRITE(LP,54) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
655   WRITE(LP,55) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
656   WRITE(LP,56) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
657   WRITE(LP,57) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
658   WRITE(LP,58) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
659   WRITE(LP,59) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
660   WRITE(LP,60) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
661   WRITE(LP,61) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
662   WRITE(LP,62) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
      GO TO 670
663   WRITE(LP,63) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
```

```
      GO TO 670
664   WRITE(LP,64) (IPRO(J,I),J=1,5),(IPRO(J,I),J=IJ,NSTOP+8)
670   CONTINUE
C
C     MOVE PROFILE IN LAST POSITION IN "IPRO" TO THE FIRST POSITION.
C     FILL REST OF "IPRO" WITH ZEROS.
C
      DO 680 I=1,MAXPRO+1
      DO 680 J=1,NSTOP+9
      IPRO(J,I)=0
680   IF(I.EQ.1)  IPRO(J,I)=IPRO(J,MAXPRO+1)
C
C     DONE WITH PAGE PRINTOUT. NOW ONLY 1 PROFILE LEFT IN "IPRO".
C
      NPRO=1
C
C     IF MORE PROFILES FOLLOW EXECUTE FORM FEED AND GO READ THEM IN.
C
      IF(MORE.NE.2HYE)  GO TO 690
      WRITE(LP,47)
      GO TO 200
C
C     IF "IPRO" WAS FULL THERE'S ONE MORE PROFILE TO PRINT OUT.
C
690   IF(FULBUF)  GO TO 570
C
C     PRINT OUT DELIMITER LINE ,FROM FEED LINE PRINTER, STOP.
C
      WRITE(LP,46)
      WRITE(LP,47)
      STOP
      END
      END$
```

ANNEX B

DECOMPRESSION MODEL SUBROUTINE LISTINGS

ANNEX B-1

SUBROUTINE BLOC7
LISTING

```
&BLOC7 T=00004 IS ON CR00012 USING 00010 BLKS R=0000

FTN4
      BLOCK DATA, BLOC7 24 SEPT 82 VER 1.1
C
C     INITIALIZES DATA IN MODEL COMMON BLOCKS "PARAM" AND "BLDVL".
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                    @
C                   @             WRITTEN BY             @
C                   @                                    @
C                   @  CDR EDWARD D. THALMANN (MC) USN   @
C                   @                                    @
C                   @                                    @
C                   @   U.S. NAVY EXPERIMENTAL DIVING    @
C                   @               UNIT                 @
C                   @   PANAMA CITY,FLORIDA      32407   @
C                   @                                    @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C**********************************************************************
C                                ************
C                                * VARIABLES *
C                                ************
C
C     AMBAO2        AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     HLFTM         COMPARTMENT HALFTIMES (MIN)
C     IAD           INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     M             COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS         NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P             COMPARTMENT GAS TENSION ARRAY (FSW)
C     PACO2         ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C     PBOVP         GAS PHASE OVERPRESSURE (FSW)
C     PH2O          PARTIAL PRESSURE OF WATER VAPOR (FSW)
C     PVCO2         VENOUS CO2 PARTIAL PRESSURE (FSW)
C     PVO2          VENOUS O2 PARTIAL PRESSURE (FSW)
C     SDR           SATURATION-DESATURATION HALFTIME RATIO
C
C
C     NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C**********************************************************************
C
      COMMON/MDATA/TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
      COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
      COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
      REAL M
C
C     COMMON BLOCK "PARAM".
C
      DATA M,P,HLFTM,NTISS,SDR,IAD
     */ 279*0.,  5.,10.,20.,40.,80.,120.,160.,200.,240.,9,9*1.0,0/
C
C     COMMON BLOCK "BLDVL"
C
      DATA PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP/1.5,0.0,2.3,2.0,0.0,0.0/
      END
```

```
0058          END$
```

ANNEX 3-2

SUBROUTINE UPDT7
EXPONENTIAL-LINEAR VERSION
LISTING

```
$UPDT7 T=00004 IS ON CR00012 USING 00100 BLKS R=0000

FTN4
      SUBROUTINE UPDT7, 24 SEPT 82 VER 1.2
C
C
C                            EXPONENTIAL-LINEAR VERSION
C
C     UPDATES THE TISSUE INERT GAS TENSIONS IN ARRAY "P" OVER A SPECIFIC
C     TIME INTERVAL "TC" FOR A SPECIFIED DEPTH CHANGE "DC". A VALUE OF
C     0.0 IS LEGAL FOR BOTH "TC" AND "DC". ASSUMES GAS UPTAKE AND
C     ELIMINATION IS EXPONENTIAL UNTIL THE TOTAL TISSUE GAS TENSION
C     EXCEEDS AMBIENT BY THE GAS PHASE OVERPRESSURE "PBOVP". AT THIS
C     POINT GAS ELIMINATION BECOMES LINEAR. PROVISION IS MADE FOR
C     DIFFERENT EXPONENTIAL TIME CONSTANTS FOR UPTAKE AND ELIMINATION.
C     THE TRANSITION BETWEEN THE TWO TIME CONSTANTS IS ALWAYS MADE AT A
C     MAXIMUM OR MINIMUM SO THERE IS NO DISCONTINUITY IN THE SLOPE OF
C     THE EXPONENTIAL FUNCTION.
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                    @
C                   @             WRITTEN BY             @
C                   @                                    @
C                   @  CDR EDWARD D. THALMANN (MC) USN   @
C                   @                                    @
C                   @                                    @
C                   @   U.S. NAVY EXPERIMENTAL DIVING    @
C                   @               UNIT                 @
C                   @   PANAMA CITY,FLORIDA      32407   @
C                   @                                    @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*******************************************************************
C                                *************
C                                * VARIABLES *
C                                *************
C
C     A              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     AMBAO2         AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     B              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     C              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     CDEPTH         CURRENT DEPTH (FSW OR MSW)
C     CF             METRIC CONVERSION FACTOR
C     CPO2           CONSTANT PARTIAL PRESSSURE O2?
C     D              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     DC             DEPTH CHANGE (FSW OR MSW)
C     DESAT          TISSUE DESATURATING?
C     DINC           STOP DEPTH INCREMENTS (MSW OR FSW)
C     DY             DERIVITIVE OF NEWTON-RAPHSON NULL VARIABLE
C     EXPN           NATURAL LOG BASE E RAISED TO THE "K*T" POWER
C     FN2            INERT GAS FRACTION
C     HLFTM          TISSUE HALFTIMES (MIN)
C     IAD            INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IJ             DEPTH (ROW) SUBSCRIPT FOR ARRAY "M"
C     IPRNT          CAUSES PRINTOUT DURING NEWTON-RAPHSON ITERATION IF 1
C     K              EXPONENTIAL TIME CONSTANT (1/MIN)
C     KDSAT          TIME CONSTANT FOR DESATURATING TISSUES (1/MIN)
```

```
C       KSAT            TIME CONSTANT FOR SATURATING TISSUES (1/MIN)
C       M               TISSUE MAXIMUM GAS TENSION ARRAY (FSW)
C       NITR            NUMBER OF TIMES NEWTON-RAPHSON ITERATION PERFORMED
C       NTISS           NUMBER OF HALFTIME TISSUES (9 MAX.)
C       P               TISSUE GAS TENSION ARRAY (FSW)
C       PACO2           ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C       PAMB            AMBIENT PRESSURE (FSW)
C       PAN2            ARTERIAL INERT GAS TENSION (FSW)
C       PAO2            ARTERIAL O2 TENSION (FSW)
C       PBOVP           GAS PHASE OVERPRESSURE (FSW)
C       PH2O            PARTIAL PRESSURE OF WATER VAPOR (FSW)
C       PO2             INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C       PTISS           TISSUE DISSOLVED INERT GAS TENSION (FSW)
C       PVCO2           VENOUS CO2 PARTIAL PRESSURE (FSW)
C       PVN2            VENOUS INERT GAS TENSION (FSW)
C       PVO2            VENOUS O2 PARTIAL PRESSURE (FSW)
C       PVSAT           INERT GAS TENSION NEEDED FOR VENOUS SATURATION (FSW)
C       RAMB            RATE OF AMBIENT PRESSURE CHANGE (FSW/MIN)
C       RATE            RATE OF DEPTH CHANGE (FSW OR MSW/MIN)
C       RINRT           RATE OF INSPIRED INERT GAS TENSION CHANGE (FSW/MIN)
C       RO2             RATE OF INSPIRED O2 TENSION CHANGE (FSW/MIN)
C       SHCHK           VARIABLE USED TO CHECK FOR SIGN CHANGE
C       SDR             SATURATION-DESATURATION HALFTIME RATIO
C       T               TIME (MIN)
C       T1              TRIAL TIME IN NEWTON-RAPHSON ITERATION (MIN)
C       TC              TIME CHANGE DURING ASCENT (MIN)
C       TERROR          MAXIMUM TIME ERROR IN NEWTON-RAPHSON ITERATION (MIN)
C       TEXP            TIME FOR EXPONENTIAL UPDATE (MIN)
C       TI              TIME INTERVAL FOR LINEAR-EXPONENTIAL CROSSOVER (MIN)
C       TLIN            TIME FOR LINEAR UPDATE (MIN)
C       TMODE           TIME OF MINIMUM OR MAXIMUM TISSUE TENSION (MIN)
C       TXOVER          TIME TO CROSSOVER TO OTHER GAS TRANSPORT MODE (MIN)
C       VALIT           ARRAY FOR STORING NEWTON-RAPHSON VALUES
C       Y               NEWTON-RAPHSON NULL VARIABLE
C       Y1              TRIAL VALUE OF "Y"
C
C
C       NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW=1 ATA.
C
C
C*****************************************************************************
C
C*****************************************************************************
C                               ******************************
C                               * SUBROUTINES REQUIRED *
C                               ******************************
C
C                                       NONE
C
C*****************************************************************************
C
C                         MODEL INPUT VARIABLES
C       THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C       MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C       SUBROUTINES.
C
        COMMON/MDATA/ TC,DC,DEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                              MODEL COMMON
C       THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
```

```
C     THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
      COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
      COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
      LOGICAL CPO2,DESAT
      REAL M,K,KSAT,KDSAT,VALIT(4,10)
C
1     FORMAT(//10X"NEWTON RAPHSON ITERATION"//
     *4X"HLFTM"2X"CEDPTH"5X"TC"8X"PTISS"8X"RATE"8X"RINRT"7X"PAN2"
     *7X"PVSAT "9X"A"11X"B"11X"C"/4X,I4,4X,I4,9(F11.6,1X)//
     *9X"T"17X"Y"14X"DY"13X" Y/DY"/10(4F16.7/)////)
C
C*********************************************************************
C
C                        INITIALIZATION PROCEDURE
C
C     SET IPRNT=1 IF ITERATION VALUES ALWAYS WANTED,OTHERWISE LEAVE AS
C     0. ITERATION VALUES ALWAYS PRINTED IF ERROR LIMITS EXCEEDED.
C
C*********************************************************************
C
      IPRNT=0
C
C     IF TIME INTERVAL "TC" IS 0 NO UPDATE NEEDED.
C
      IF(TC.EQ.0.0) RETURN
C
C     RATES OF AMBIENT PRESSURE CHANGE ALWAYS IN FEET/MIN, CONVERT
C     METRIC RATES TO FEET/MIN. SET RATE TO 0 IF NO DEPTH CHANGE.
C     COMPUTE INITIAL AMBIENT PRESSURE.
C
      RAMB=CF*RATE
      IF(DC.EQ.0.) RAMB=0.
      PAMB=CDEPTH*CF+33
C
C     FOLLOWING VARIABLES DEPEND ON WHETHER CONSTANT OXYGEN PARTIAL
C     PRESSURE OF CONSTANT INERT GAS FRACTION USED. LOGICAL VARIABLE
C     "CPO2" IS TRUE FOR CONSTANT PO2 OTHERWISE IT'S FALSE.
C
      IF (CPO2) GO TO 30
      PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
      RINRT=FN2*RAMB
      RO2=(1-FN2)*RAMB
      GO TO 40
30    PAO2=PO2*33*(1.0-PH2O/PAMB)-AMBAO2
      RINRT=RAMB
      RO2=0.0
40    CONTINUE
C
C*********************************************************************
C
C                    END INITIALIZATION PROCEDURE
C
C*********************************************************************
C
C
C*********************************************************************
C
```

```
C                            TISSUE UPDATE LOOP
C
C                  EXECUTE LOOP FOR ALL "NTISS" TISSUES.
C
C**********************************************************************
C
C      COMPUTE TIME CONSTANTS FOR SATURATING AND DESATURATING TISSUES
C      ("KSAT" AND "KDSAT"). INITIALIZE ARTERIAL AND VENOUS SATURATION
C      INERT GAS TENSIONS.
C
       DO 500 I=1,NTISS
       KSAT=ALOG(2.0)/HLFTM(I)
       KDSAT=KSAT*SDR(I)
       PAN2=PAMB-(PAO2+PACO2+PH2O)
       PVSAT=PAMB-(PVO2+PVCO2+PH2O)
C
C      INITIALIZE TISSUE TENSION TO DEFAULT VALUE.
C
       PTISS=P(I)
C
C      IF TISSUE TENSION INITIALLY GREATER THAN "PVSAT" GO TO LINEAR
C      UPDATE PROCEDURE.
C
       IF (PTISS.GT.(PVSAT+PBOVP)) GO TO 300
C
C**********************************************************************
C
C              EXPONENTIAL NODE TIME COMPUTATION PROCEDURE
C
C      THIS PROCEDURE CHECKS TO SEE IF INITIALLY EXPONENTIALLY SATURATING
C      OR DESATURATING TISSUES WILL GO THROUGH A MINIMUM OR MAXIMUM
C      (NODE) DURING THE TIME INTERVAL "TC". IF A NODE OCCURS THE TISSUE
C      TENSIONS ARE UPDATED TO THE TIME OF THE NODE (TNODE). THERE ARE
C      TWO EXITS FROM THIS PROCEDURE. IF NO NODE OCCURS OR IF THE TISSUE
C      REMAINS EXPONENTIAL FOR THE WHOLE TIME INTERVAL THE EXIT IS TO THE
C      EXPONENTIAL UPDATE PROCEDURE (STATEMENT 400). OTHERWISE THE EXIT
C      IS TO THE EXPONENTIAL-LINEAR CROSSOVER TIME COMPUTATION PROCEDURE
C      (STATEMENT 200).
C
C                      EXITS TO STATEMENT 200 OR 400
C
C**********************************************************************
C
C      SET "TI" (TIME REMAINING IN INTERVAL "TC" AFTER NODE HAS OCCURED)
C      TO "TC" INITIALLY. ALSO INITIALIZE "TEXP" TO "TC".
C
       TI=TC
       TEXP=TC
C
C      IF TISSUE INERT GAS TENSION GREATER THAN ARTERIAL IT'S
C      DESATURATING OTHERWISE IT'S SATURATING ("DESAT" IS FALSE).
C
       DESAT=.FALSE.
       IF(PTISS.GT.PAN2) DESAT=.TRUE.
C
C      IF INITIALLY SATURATING AND DESCENDING,NO NODE WILL OCCUR DURING
C      "TC" AND TISSUE CONTINUES SATURATING EXPONENTIALLY.
C
       IF(RATE.GT.0 .AND. .NOT.DESAT) GO TO 400
C
```

```
C      INITIALLY DESATURATING TISSUES UNDERGOING ASCENT HAVE NO NODE.
C      TISSUE CONTINUES DESATURATING AND A CROSSOVER TO LINEAR DESAT-
C      URATION WILL OCCUR SO GO TO CROSSOVER TIME COMPUTATION PROCEDURE.
C
       IF(RATE.LT.0 .AND. DESAT) GO TO 200
C
C      AT THIS POINT THE ONLY TISSUE CONDITIONS WHICH HAVE NOT BEEN
C      ELIMINATED ARE INITIALLY EXPONENTIALLY SATURATING UNDERGOING
C      ASCENT OR INITIALLY EXPONENTIALLY DESATURATING UNDERGOING
C      DESCENT. IF "RATE" IS 0 NO NODE FOR EITHER CONDITION AND
C      TISSUE WILL STAY IN THE EXPONENTIAL MODE.
C
       IF (RATE.EQ.0) GO TO 400
C
C      COMPUTE TIME AT WHICH NODE WILL OCCUR (TNODE).
C
       K=KSAT
       IF(DESAT) K=KDSAT
       C=(K/RINRT)*(PTISS-PAN2)
       TNODE=(1/K)*ALOG(C+1.0)
C
C      IF "TNODE" IS 0 GO TO EXPONENTIAL-LINEAR CROSSOVER TIME PROCEDURE.
C      (CAN ONLY HAPPEN FOR INITIALLY SATURATED TISSUE UNDERGOING ASCENT)
C
       IF(TNODE.LE.0.0) GO TO 200
C
C      IF "TNODE" GREATER THAN THE TIME INCREMENT "TC" THERE IS NO NODE
C      AND TISSUE REMAINS IN THE EXPONENTIAL MODE.
C
       IF(TNODE.GE.TC) GO TO 400
C
C      UPDATE "PAN2","PVSAT" TO "TNODE" AND COMPUTE A NEW TIME INTERVAL
C      "TI". AT "TNODE" TISSUE AND ARTERIAL INERT GAS TENSION ARE EQUAL
C      BY DEFINITION.
C
       PAN2=PAN2+RINRT*TNODE
       PVSAT=PVSAT+RINRT*TNODE
       TI=TC-TNODE
       PTISS=PAN2
C
C      EXPONENTIAL UPDATE TIME INITIALLY ASSUMED TO EQUAL "TI".
C
       TEXP=TI
C
C      IF THE TISSUE WAS INITIALLY SATURATING THEN AFTER THE NODE IT WILL
C      BE DESATURATING AND A CROSSOVER TO THE LINEAR MODE MAY OCCUR.
C
       IF(.NOT.DESAT) GO TO 200
C
C      AT THIS POINT ONLY THE DESATURATING TISSUE IS LEFT AND AFTER THE
C      NODE IT WILL BE SATURATING AND THEREFORE WILL REMAIN IN THE
C      EXPONENTIAL MODE. SET "DESAT" TO FALSE BEFORE GOING TO THE
C      EXPONENTIAL UPDATE PROCEDURE.
C
       DESAT=.FALSE.
       GO TO 400
C
C*********************************************************************
C
C                    END OF EXPONENTIAL NODE TIME PROCEDURE
```

```
C
C*****************************************************************
C
C
C*****************************************************************
C
C          EXPONENTIAL-LINEAR CROSSOVER TIME COMPUTATION PROCEDURE
C
C
C     THIS PROCEDURE COMPUTES THE TIME AT WHICH THE TISSUE WILL GO FROM
C     THE INITIAL EXPONENTIAL DESATURATION MODE TO THE LINEAR
C     DESATURATION MODE. THIS CROSSOVER OCCURS AT THE TIME WHEN THE
C     TOTAL TISSUE GAS TENSION EXCEEDS THE TOTAL AMBIENT PRESSURE BY
C     THE GAS PHASE OVERPRESSURE (PBOVP), THAT IS WHEN:
C
C     (1)        P(I)+PVO2+PVCO2+PH2O=PAMB+RAMB*T+PBOVP
C
C     WHERE FOR THE CONDITION WHERE NO GAS PHASE IS PRESENT:
C
C     (2)    P(I)=(PTISS-PAN2+RINRT/K)*(EXP(-K*T)-1)+RINRT*T+PTISS
C
C     "PTISS" AND "PAMB" ARE THE VALUES OF THE TISSUE INERT GAS TENSION
C     AND AMBIENT PRESSURE RESPECTIVELY AT THE START OF THE DEPTH
C     CHANGE. "RAMB" IS THE RATE OF DEPTH CHANGE AND "T" THE TIME SINCE
C     THE BEGINNING OF THE DEPTH CHANGE. "K" IS THE EXPONENTIAL TIME
C     CONSTANT WHICH IS EQUAL TO EITHER "KSAT" OR "KDSAT" DEPENDING ON
C     WHETHER THE TISSUE IS SATURATING OR DESATURATING. IN THE CONSTANT
C     PO2 MODE "RAMB" AND "RINRT" ARE EQUAL AND EQUATION(1) CAN BE
C     SOLVED FOR "T" (SEE STATEMENT 210). IN THE CONSTANT INERT FRACTION
C     MODE "RAMB" AND "RINRT" ARE NOT EQUAL AND EQUATION(1) CANNOT BE
C     EXPLICITLY SOLVED FOR "T" AND MUST BE SOLVED BY ITERATION.
C
C
C     THE ONLY EXIT IS TO THE LINEAR UPDATE PROCEDURE AT STATEMENT 450.
C
C*****************************************************************
C
C     CROSSOVER TIME INITIALLY ASSUMED EQUAL TO "TI".
C
200   TXOVER=TI
C
C     SEE IF EQUATION(2) ASYMPTOTE LINE INTERCEPT GREATER THAN THAT OF
C     THE CROSSOVER PRESSURE LINE, IF IT IS CROSSOVER WILL ALWAYS OCCUR
C     SO GO COMPUTE CROSSOVER TIME.
C
      IF(RINRT.LT.(KDSAT*(PAN2-(PVSAT+PBOVP)))) GO TO 210
C
C     IF ASYMPTOTE INTERCEPT NOT GREATER THAN THAT OF CROSSOVER LINE
C     NO CROSSOVER OCCURS IF PO2 IS CONSTANT.
C
      IF(CPO2) GO TO 400
C
C     COMPUTE TIME WHERE ASYMPTOTE INTERSECTS CROSSOVER LINE.
C
      T=(PAN2-(PVSAT+PBOVP)-RINRT/KDSAT)/(RAMB-RINRT)
C
C     IF "T" GREATER OR EQUAL TO THE TIME INTERVAL "TI" NO CROSSOVER.
C     IF NOT, "T" USED AS TRIAL TIME TO START ITERATION.
C
      IF(T.GE.TI) GO TO 400
```

```
      GO TO 220
C
C     COMPUTE THE CROSSOVER TIME ASSUMING THAT A CONSTANT PO2 IS BEING
C     USED.
C
210   T=-(1/KDSAT)*ALOG(1-(PTISS-(PVSAT+PBOVP))/(PTISS-PAN2+RAMB/KDSAT))
C
C     IF IN CONSTANT PO2 MODE, THEN THE ABOVE TIME IS THE EXACT
C     TIME TO CROSSOVER. IF WE'RE IN THE CONSTANT INERT GAS FRACTION
C     MODE THEN "T" IS THE MAXIMUM TIME TO CROSSOVER AND IS USED AS A
C     STARTING POINT FOR THE ITERATION.
C
      IF(CPO2) GO TO 280
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                        NEWTON RAPHSON ITERATION
C
C     IF WE'RE IN THE CONSTANT INERT GAS FRACTION MODE THE CROSSOVER
C     TIME IS THE INDEPENDANT VARIABLE IN THE NON-INVERTABLE EQUATION(1)
C     AND CAN ONLY BE COMPUTED BY ITERATION.
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     COMPUTE CONSTANTS FOR ITERATION
C
220   A=(PTISS-PAN2+RINRT/KDSAT)
      B=(PVSAT+PBOVP-PTISS)
      C=RAMB-RINRT
      NITR=0
C
C     "Y" IS THE NULL FUNCTION WHICH WILL BE EXACTLY 0.0 WHEN "T" IS
C     EXACTLY THE CROSSOVER TIME. "DY" IS THE FIRST DERIVITIVE OF "Y".
C
230   EXPN=EXP(-KDSAT*T)
      Y=B-A*(EXPN-1)+C*T
      DY=C+KDSAT*A*EXPN
C
C     SEED ERROR CHECK WITH "T" AND "Y" ON FIRST PASS.
C
      IF(NITR.GT.0) GO TO 240
      T1=T
      Y1=Y
240   NITR=NITR+1
C
C     SAVE ITERATION VALUES FOR IN CASE PRINTOUT OCCURS.
C
      VALIT(1,NITR)=T
      VALIT(2,NITR)=Y
      VALIT(3,NITR)=DY
      VALIT(4,NITR)=Y/DY
C
C     STOP ITERATION IF "Y" AND "Y/DY" ARE BOTH LESS THAN THE ACCEPTABLE
C     ERROR.
C
      IF(ABS(Y/DY).LE.0.00001 .AND. ABS(Y).LT.0.001) GO TO 270
C
C     STOP ITERATION AFTER 10 PASSES NO MATTER WHAT.
C
      IF(NITR.EQ.10) GO TO 270
```

```
C
C      IF "Y" HAS UNDERGONE A SIGN CHANGE SINCE LAST RECORDING "T1" THEN
C      "ABS(T-T1)" IS THE MAXIMUM ERROR FOR "T". IF THIS ERROR IS
C      ACCEPTABLE THEN STOP ITERATION. THIS TERMINATES ITERATIONS WHERE
C      "Y" OSCILLATES AROUND ZERO MORE RAPIDLY. IF "SCHK" IS POSITIVE
C      THEN NO SIGN CHANGE OCCURED AND NO ERROR CHECK MADE.
C
       SCHK=SIGN(1.0,Y)*SIGN(1.0,Y1)
       IF(SCHK.GT.0) GO TO 260
       TERROR=ABS(T1-T)
       IF(TERROR.LT.0.0001) GO TO 270
       T1=T
       Y1=Y
C
C      COMPUTE NEW ESTIMATE OF THE CROSSOVER TIME FOR THE NEXT PASS.
C
260    T=T-(Y/DY)
       GO TO 230
C
C      WRITE OUT ITERATION VALUES IF CONVERGENCE TO ERROR LIMITS HAS NOT
C      OCCURED IN 10 ITERATIONS OR IF PRINT MODE ON (IPRNT=1).
C
270    IF(NITR.LT.10 .AND. IPRNT.EQ.0) GO TO 280
       WRITE(6,1) HLFTM(I),CDEPTH,TI,PTISS,RAMB,RINRT,PAN2,PVSAT,A,B,C,
      *((VALIT(J,L),J=1,4),L=1,NITR)
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                      END OF NEWTON RAPHSON ITERATION
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C      CROSSOVER TIME IS THE VALUE OF "T" AT THE FINISH OF THE NEWTON
C      RAPHSON ITERATION OR THE VALUE COMPUTED IN STATEMENT 210 IF IN THE
C      CONSTANT PO2 MODE. IF CROSSOVER TIME EXCEEDS "TI" GO TO
C      EXPONENTIAL UPDATE.
C
280    TXOVER=T
       IF(T.GT.TI) GO TO 400
C
C      COMPUTE VENOUS SATURATION INERT GAS TENSION AND ARTERIAL INERT GAS
C      TENSION AT CROSSOVER TIME. BY DEFINITION THE VENOUS INERT GAS
C      TENSION EXCEEDS THE VENOUS SATURATION INERT GAS TENSION BY THE
C      GAS PHASE OVERPRESSURE (PBOVP) AT THE CROSSOVER TIME.
C
       PVSAT=PVSAT+RAMB*TXOVER
       PAN2=PAN2+RINRT*TXOVER
       PVN2=PVSAT+PBOVP
C
C      VENOUS AND DISSOLVED TISSUE INERT GAS TENSION EQUAL WHEN GAS PHASE
C      FORMS. COMPUTE TIME REMAINING FOR LINEAR UPDATE AFTER CROSSOVER.
C
       PTISS=PVN2
       TLIN=TI-TXOVER
       GO TO 450
C
C**********************************************************************
C
C              END EXP-LIN CROSSOVER TIME COMPUTATION PROCEDURE
C
```

```
C***********************************************************************
C
C***********************************************************************
C
C             LINEAR-EXPONENTIAL CROSSOVER TIME COMPUTATION PROCEDURE
C
C
C     CROSSOVER OCCURS WHEN THE TOTAL DISSOLVED INERT GAS TENSION FALLS
C     TO A LEVEL WHICH JUST EXCEEDS THE AMBIENT PRESSURE BY THE GAS
C     PHASE OVERPRESSURE (PBOVP) ,THAT IS WHEN:
C
C     (3)             P(I)+PVO2+PVCO2+PH2O=PAMB+RAMB*T+PBOVP
C
C     WHERE, WHEN A GAS PHASE IS PRESENT:
C
C     (4)    P(I)=PTISS+KDSAT*(PAN2-PVN2)*T-(RO2*KDSAT/2)*T**2
C
C     "PTISS" AND "PAMB" ARE THE TISSUE DISSOLVED INERT GAS TENSION AND
C     THE AMBIENT PRESSURE RESPECTIVELY AT THE BEGINNING OF THE LINEAR
C     DEPTH CHANGE. "RAMB" IS THE RATE OF DEPTH CHANGE AND "T" THE TIME
C     SINCE THE BEGINNING OF THE DEPTH CHANGE. EQUATION(3) CAN BE EASILY
C     SOLVED FOR "T" IN THE CONSTANT PO2 MODE SINCE "RO2" IS 0. IN THE
C     CONSTANT INERT FRACTION MODE THE QUADRATIC FORMULA MUST BE USED.
C
C***********************************************************************
C
C     TIME IN LINEAR UPDATE MODE INITIALLY ASSUMED EQUAL TO "TC".
C
300   TLIN=TC
C
C     WHEN A GAS PHASE IS PRESENT THE VENOUS INERT GAS TENSION EXCEEDS
C     THE VENOUS SATURATION INERT GAS TENSION BY THE GAS PHASE
C     OVERPRESSURE.
C
      PVN2=PVSAT+PBOVP
C
C     VARIABLES "A","B", AND "C" ARE COEFFICIENTS OF THE LINEAR-
C     EXPONENTIAL CROSSOVER TIME QUADRATIC EQUATION. "D" IS THE SQUARE
C     ROOT TERM OF THE QUADRATIC FORMULA.
C
      A=RO2*KDSAT/2
      B=RAMB-KDSAT*(PAN2-PVN2)
      C=PVN2-PTISS
      D=B**2-4*A*C
C
C     CHECK TO SEE IF NO CROSSOVER WILL OCCUR.
C
      IF (D.LT.0.0 .OR. B.LE.0.0) GO TO 450
C
C     VALUE OF CROSSOVER TIME DEPENDS ON WHETHER OR NOT THE OXYGEN
C     TENSION IS CHANGING.
C
      IF(RO2.EQ.0.0) TXOVER=-(C/B)
      IF(RO2.NE.0.0) TXOVER=(-B+SQRT(D))/(2*A)
C
C     IF CROSSOVER NOT WITHIN TIME INTERVAL "TC" STAY LINEAR.
C
      IF(TXOVER.GE.TC) GO TO 450
C
C     COMPUTE TISSUE AND ARTERIAL INERT GAS TENSION AT CROSSOVER.
```

```
C     TISSUE DISSOLVED AND VENOUS INERT GAS TENSION EQUAL AT CROSSOVER.
C     COMPUTE "TEXP" AS TIME REMAINING AFTER CROSSOVER OCCURS. AFTER
C     CROSSOVER TISSUE WILL BE EXPONENTIALLY DESATURATING.
C
      PTISS=PVN2+RAMB*TXOVER
      PAN2=PAN2+RINRT*TXOVER
      TEXP=TC-TXOVER
      DESAT=.TRUE.
C
C     EXPONENTIAL UPDATE EXPECTS TISSUES TO BE UPDATED TO A NODE IF
C     IT OCCURS. IF NO INERT GAS TENSION CHANGE OCCURS NO NODE.
C
      IF(RINRT.EQ.0) GO TO 400
C
C     COMPUTE TIME OF NODE "TNODE".
C
      C=(KDSAT/RINRT)*(PTISS-PAN2)
      TNODE=(1/KDSAT)*ALOG(C+1)
C
C     IF NODE WILL NOT OCCUR WITHIN REMAINING TIME GO DIRECTLY TO THE
C     EXPONENTIAL UPDATE.
C
      IF(TNODE.GE.TEXP) GO TO 400
C
C     UPDATE ARTERIAL INERT GAS TENSION TO "TNODE". AT "TNODE" THE
C     TISSUE AND ARTERIAL INERT GAS TENSIONS ARE EQUAL BY DEFINITION.
C
      PAN2=PAN2+RINRT*TNODE
      PTISS=PAN2
C
C     COMPUTE REMAINING TIME AFTER NODE OCCURS. TISSUE NOW SATURATING.
C
      TEXP=TEXP-TNODE
      DESAT=.FALSE.
C
C*********************************************************************
C
C                   TISSUE INERT GAS UPDATE PROCEDURES
C
C     UPDATE TISSUE TENSIONS EITHER EXPONENTIALLY OR LINEARLY AND STORE
C     RESULTS IN ARRAY "P".
C
C*********************************************************************
C
C     EXPONENTIAL UPDATE.
C
  400 K=KSAT
      IF(DESAT) K=KDSAT
      A=PTISS-PAN2+RINRT/K
      B=RINRT*TEXP+PTISS
      P(I)=A*(EXP(-K*TEXP)-1)+B
      GO TO 500
C
C     LINEAR UPDATE.
C
  450 A=KDSAT*(PAN2-PVN2)
      B=KDSAT*RO2/2
      P(I)=PTISS+A*TLIN-B*TLIN**2
C
C*********************************************************************
```

```
C
C                      END TISSUE UPDATE PROCEDURES
C
C******************************************************************
C
C     END OF UPDATE, GO UPDATE NEXT TISSUE OR DROP THROUGH TO COMPUTE
C     THE INSTANTANEOUS ASCENT DEPTH IF ALL "NTISS" TISSUES HAVE BEEN
C     UPDATED.
C
500   CONTINUE
C
C******************************************************************
C
C                      END OF TISSUE UPDATE LOOP
C
C******************************************************************
C
C******************************************************************
C
C                INSTANTANEOUS ASCENT DEPTH COMPUTATION PROCEDURE
C
C     START AT 30 DEPTH INCREMENTS AND WORK UP ONE DEPTH INCREMENT AT A
C     TIME UNTIL AT LEAST ONE TISSUE TENSION EXCEEDS ITS MAXIMUM
C     ALLOWABLE VALUE.
C
C******************************************************************
C
      IJ =30
      DO 550 J=1,30
      DO 510 I=1,NTISS
      IF(P(I).GT.M(I,IJ)) GO TO 600
510   CONTINUE
550   IJ=IJ-1
C
C     SUBSCRIPT "IJ" OF ARRAY "M" SPECIFIES NUMBER OF DEPTH INCREMENTS
C     FOR THE INSTANTANEOUS ASCENT DEPTH (IAD).
C
600   IAD=DINC*IJ
C
C******************************************************************
C
C          END INSTANTANEOUS ASCENT DEPTH COMPUTATION PROCEDURE
C
C******************************************************************
C
C     ALL DONE, RETURN
C
      RETURN
      END
      END$
```

ANNEX B-3

SUBROUTINE UPDT7
EXPONENTIAL-EXPONENTIAL VERSION
LISTING

```
$UPDTE T=00004 IS ON CR00012 USING 00097 BLKS R=0000

FTN4
      SUBROUTINE UPDT7, 24 SEPT 82 VER 2.1
C
C
C                              EXPONENTIAL-EXPONENTIAL VERSION
C
C     UPDATES THE TISSUE INERT GAS TENSIONS IN ARRAY "P" OVER A SPECIFIC
C     TIME INTERVAL "TC" FOR A SPECIFIED DEPTH CHANGE "DC". A VALUE OF
C     0.0 IS LEGAL FOR BOTH "TC" AND "DC". ASSUMES GAS UPTAKE AND
C     ELIMINATION IS ALWAYS EXPONENTIAL. PROVISION IS MADE FOR
C     DIFFERENT EXPONENTIAL TIME CONSTANTS FOR UPTAKE AND ELIMINATION.
C     THE TRANSITION BETWEEN THE TWO TIME CONSTANTS IS ALWAYS MADE AT A
C     MAXIMUM OR MINIMUM SO THERE IS NO DISCONTINUITY IN THE SLOPE OF
C     THE EXPONENTIAL FUNCTION.
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                   @
C                   @             WRITTEN BY            @
C                   @                                   @
C                   @  CDR EDWARD D. THALMANN (MC) USN  @
C                   @                                   @
C                   @                                   @
C                   @   U.S. NAVY EXPERIMENTAL DIVING   @
C                   @               UNIT                @
C                   @   PANAMA CITY,FLORIDA      32407  @
C                   @                                   @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C***********************************************************************
C                                   *************
C                                   * VARIABLES *
C                                   *************
C
C     A              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     AMBAO2         AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     B              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     C              INTERMEDIATE VARIABLE FOR COMPUTATIONS
C     CDEPTH         CURRENT DEPTH (FSW OR MSW)
C     CF             METRIC CONVERSION FACTOR
C     CPO2           CONSTANT PARTIAL PRESSSURE O2?
C     DC             DEPTH CHANGE (FSW OR MSW)
C     DESAT          TISSUE DESATURATING?
C     DINC           STOP DEPTH INCREMENTS (MSW OR FSW)
C     FN2            INERT GAS FRACTION
C     HLFTM          TISSUE HALFTIMES (MIN)
C     IAD            INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IJ             DEPTH (ROW) SUBSCRIPT FOR ARRAY "M"
C     K              EXPONENTIAL TIME CONSTANT (1/MIN)
C     KDSAT          TIME CONSTANT FOR DESATURATING TISSUES (1/MIN)
C     KSAT           TIME CONSTANT FOR SATURATING TISSUES (1/MIN)
C     M              TISSUE MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS          NUMBER OF HALFTIME TISSUES (9 MAX.)
C     P              TISSUE GAS TENSION ARRAY (FSW)
C     PACO2          ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C     PAMB           AMBIENT PRESSURE (FSW)
```

```
C      PAN2           ARTERIAL INERT GAS TENSION (FSW)
C      PAO2           ARTERIAL O2 TENSION (FSW)
C      PBOVP          GAS PHASE OVERPRESSURE (FSW)
C      PH2O           PARTIAL PRESSURE OF WATER VAPOR (FSW)
C      PO2            INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C      PTISS          TISSUE DISSOLVED INERT GAS TENSION (FSW)
C      PVCO2          VENOUS CO2 PARTIAL PRESSURE (FSW)
C      PVO2           VENOUS O2 PARTIAL PRESSURE (FSW)
C      RAMB           RATE OF AMBIENT PRESSURE CHANGE (FSW/MIN)
C      RATE           RATE OF DEPTH CHANGE (FSW OR MSW/MIN)
C      RINRT          RATE OF INSPIRED INERT GAS TENSION CHANGE (FSW/MIN)
C      SDR            SATURATION-DESATURATION HALFTIME RATIO
C      TC             TIME CHANGE DURING ASCENT (MIN)
C      TI             TIME INTERVAL FOR LINEAR-EXPONENTIAL CROSSOVER (MIN)
C      TMODE          TIME OF MINIMUM OR MAXIMUM TISSUE TENSION (MIN)
C
C
C      NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW=1 ATA.
C
C
C*********************************************************************
C
C*********************************************************************
C                            *********************
C                            * SUBROUTINES REQUIRED *
C                            *********************
C
C                                       NONE
C
C*********************************************************************
C
C                         MODEL INPUT VARIABLES
C      THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C      MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C      SUBROUTINES.
C
       COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                              MODEL COMMOM
C      THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C      THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
       COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
       COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
       LOGICAL CPO2,DESAT
       REAL M,K,KSAT,KDSAT
C
C*********************************************************************
C
C                          INITIALIZATION PROCEDURE
C
C
C*********************************************************************
C
C      IF TIME INTERVAL "TC" IS 0 NO UPDATE NEEDED.
C
       IF(TC.EQ.0.0) RETURN
C
```

```
C     RATES OF AMBIENT PRESSURE CHANGE ALWAYS IN FEET/MIN, CONVERT
C     METRIC RATES TO FEET/MIN. SET RATE TO 0 IF NO DEPTH CHANGE.
C     COMPUTE INITIAL AMBIENT PRESSURE.
C
      RAMB=CF*RATE
      IF(DC.EQ.0.) RAMB=0.
      PAMB=CDEPTH*CF+33
C
C     FOLLOWING VARIABLES DEPEND ON WHETHER CONSTANT OXYGEN PARTIAL
C     PRESSURE OF CONSTANT INERT GAS FRACTION USED. LOGICAL VARIABLE
C     "CPO2" IS TRUE FOR CONSTANT PO2 OTHERWISE IT'S FALSE.
C
      IF(CPO2) GO TO 30
      PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
      RINRT=FN2*RAMB
      GO TO 40
30    PAO2=PO2*33*(1.0-PH2O/PAMB)-AMBAO2
      RINRT=RAMB
40    CONTINUE
C
C*****************************************************************************
C
C                        END INITIALIZATION PROCEDURE
C
C*****************************************************************************
C
C
C*****************************************************************************
C
C                             TISSUE UPDATE LOOP
C
C                    EXECUTE LOOP FOR ALL "NTISS" TISSUES.
C
C*****************************************************************************
C
C     COMPUTE TIME CONSTANTS FOR SATURATING AND DESATURATING TISSUES
C     ("KSAT" AND "KDSAT"). INITIALIZE ARTERIAL INERT GAS TENSION.
C
      DO 500 I=1,NTISS
      KSAT=ALOG(2.0)/HLFTM(I)
      KDSAT=KSAT*SDR(I)
      PAN2=PAMB-(PAO2+PACO2+PH2O)
C
C     INITIALIZE TISSUE TENSION TO DEFAULT VALUE.
C
      PTISS=P(I)
C
C*****************************************************************************
C
C                        NODE TIME COMPUTATION PROCEDURE
C
C     THIS PROCEDURE CHECKS TO SEE IF INITIALLY EXPONENTIALLY SATURATING
C     OR DESATURATING TISSUES WILL GO THROUGH A MINIMUM OR MAXIMUM
C     (NODE) DURING THE TIME INTERVAL "TC". IF A NODE OCCURS THE TISSUE
C     TENSIONS ARE UPDATED TO THE TIME OF THE NODE (TNODE) BEFORE GOING
C     TO THE EXPONENTIAL UPDATE PROCEDURE.
C
C                        EXITS TO STATEMENT 400
C
C*****************************************************************************
```

```
C
C     SET "TI" (TIME REMAINING IN INTERVAL "TC" AFTER NODE HAS OCCURED)
C     TO "TC" INITIALLY.
C
      TI=TC
C
C     IF TISSUE INERT GAS TENSION GREATER THAN ARTERIAL IT'S
C     DESATURATING OTHERWISE IT'S SATURATING ("DESAT" IS FALSE).
C
      DESAT=.FALSE.
      IF(PTISS.GT.PAN2) DESAT=.TRUE.
C
C     IF NO DEPTH CHANGE NO NODE WILL OCCUR.
C
      IF(RATE.EQ.0.0) GO TO 400
C
C     IF INITIALLY SATURATING AND DESCENDING,NO NODE WILL OCCUR DURING
C     "TC" AND TISSUE CONTINUES SATURATING EXPONENTIALLY.
C
      IF(RATE.GT.0 .AND. .NOT.DESAT) GO TO 400
C
C     INITIALLY DESATURATING TISSUES UNDERGOING ASCENT HAVE NO NODE.
C     TISSUE CONTINUES DESATURATING EXPONENTIALLY.
C
      IF(RATE.LT.0 .AND. DESAT) GO TO 400
C
C     COMPUTE TIME AT WHICH NODE WILL OCCUR (TNODE).
C
      K=KSAT
      IF(DESAT) K=KDSAT
      C=(K/RINRT)*(PTISS-PAN2)
      TNODE=(1/K)*ALOG(C+1)
C
C     IF "TNODE" GREATER THAN THE TIME INCREMENT "TC" OR IS LESS THAN
C     0.0 THE NODE WILL NOT OCCUR WITHIN THE TIME INTERVAL.
C
      IF(TNODE.GE.TC .OR. TNODE.LE.0.0) GO TO 400
C
C     UPDATE "PAN2" TO "TNODE" AND COMPUTE A NEW TIME INTERVAL
C     "TI". AT "TNODE" TISSUE AND ARTERIAL INERT GAS TENSION ARE EQUAL
C     BY DEFINITION.
C
      PAN2=PAN2+RINRT*TNODE
      TI=TC-TNODE
      PTISS=PAN2
C
C     AFTER THE NODE TISSUE GAS TRANSFER IS OPPOSITE TO WHAT IT WAS
C     INITIALLY.
C
      DESAT=.NOT.DESAT
C
C******************************************************************
C
C                     END NODE TIME COMPUTATION PROCEDURE
C
C******************************************************************
C
C******************************************************************
C
C                        EXPONENTIAL UPDATE PROCEDURE
```

```
C
C*********************************************************************
400   K=KSAT
      IF(DESAT) K=KDSAT
      A=PTISS-PAN2+RINRT/K
      B=RINRT*TI+PTISS
      P(I)=A*(EXP(-K*TI)-1)+B
C
C*********************************************************************
C
C                    END EXPONENTIAL UPDATE PROCEDURE
C
C*********************************************************************
C
C     END OF UPDATE, GO UPDATE NEXT TISSUE OR DROP THROUGH TO COMPUTE
C     THE INSTANTANEOUS ASCENT DEPTH IF ALL "NTISS" TISSUES HAVE BEEN
C     UPDATED.
C
500   CONTINUE
C
C#####################################################################
C
C                    END OF TISSUE UPDATE LOOP
C
C#####################################################################
C
C*********************************************************************
C
C               INSTANTANEOUS ASCENT DEPTH COMPUTATION PROCEDURE
C
C     START AT 30 DEPTH INCREMENTS AND WORK UP ONE DEPTH INCREMENT AT A
C     TIME UNTIL AT LEAST ONE TISSUE TENSION EXCEEDS ITS MAXIMUM
C     ALLOWABLE VALUE.
C
C*********************************************************************
C
      IJ =30
      DO 550 J=1,30
      DO 510 I=1,NTISS
      IF(P(I).GT.M(I,IJ)) GO TO 600
510   CONTINUE
550   IJ=IJ-1
C
C     SUBSCRIPT "IJ" OF ARRAY "M" SPECIFIES NUMBER OF DEPTH INCREMENTS
C     FOR THE INSTANTANEOUS ASCENT DEPTH (IAD).
C
600   IAD=DINC*IJ
C
C*********************************************************************
C
C          END INSTANTANEOUS ASCENT DEPTH COMPUTATION PROCEDURE
C
C*********************************************************************
C
C     ALL DONE, RETURN
C
      RETURN
      END
      END$
```

ANNEX B-4

SUBROUTINE FRSP7 LISTING

```
&FRSP7 T=00004 IS ON CR00012 USING 00032 BLKS R=0000

FTN4
      SUBROUTINE FRSP7(DFS), 01 MAR  83 VER 1.2
C
C
C          FINDS DEPTH OF FIRST STOP (DFS). TRIAL STOP DEPTH (MIND)
C     INITIALLY SET TO CURRENT INSTANTANEOUS ASCENT DEPTH (IAD). A
C     TRIAL ASCENT TO "MIND" IS DONE TO SEE IF "IAD" CHANGES DURING
C     ASCENT. IF "IAD" CHANGES A NEW TRIAL ASCENT FROM "CDEPTH" TO THE
C     NEW "IAD" IS DONE. ITERATION CONTINUES UNTIL THE "IAD" AFTER
C     ASCENT AND "MIND" ARE EQUAL.
C.
C          DEPTH OF FIRST STOP WILL NEVER BE DEEPER THAN THE CURRENT
C     DEPTH. IF ASCENTS ALWAYS ACCOMPANIED BY APPROPRIATE DECOMPRESSION
C     NO PROBLEMS WILL OCCUR. HOWEVER, IF AN ASCENT IS TAKEN WITHOUT
C     DECOMPRESSION STOPS THEN A FIRST STOP DEPTH SOUGHT, THE "IAD" MAY
C     BE DEEPER THAN THE CURRENT DEPTH. IN THESE CASES THE FIRST STOP
C     DEPTH WILL BE THE CURRENT DEPTH.
C
C
C                  @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                  @                                    @
C                  @             WRITTEN BY             @
C                  @                                    @
C                  @  CDR EDWARD D. THALMANN (MC) USN   @
C                  @                                    @
C                  @                                    @
C                  @   U.S. NAVY EXPERIMENTAL DIVING    @
C                  @               UNIT                 @
C                  @   PANAMA CITY,FLORIDA     32407    @
C                  @                                    @
C                  @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C#####################################################################
C                             ***********
C                             * VARIABLES *
C                             ***********
C
C     AMBAO2         AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH         CURRENT DEPTH (FSW OR MSW)
C     CF             METRIC CONVERSION FACTOR
C     CPO2           CONSTANT PARTIAL PRESSSURE O2?
C     DC             DEPTH CHANGE (FSW OR MSW)
C     DFS            DEPTH OF FIRST STOP (FSW OR MSW)
C     DINC           STOP DEPTH INCREMENTS (FSW OR MSW)
C     FN2            INERT GAS FRACTION
C     HLFTM          COMPARTMENT HALFTIMES (MIN)
C     IAD            INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IADTMP         VARIABLE TO TEMORARILY STORE CURRENT VALUE OF "IAD".
C     LASTIT         LAST TIME THROUGH ITERATION LOOP?
C     M              COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     MIND           TRIAL FIRST STOP DEPTH (FSW OR MSW)
C     NTISS          NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P              COMPARTMENT GAS TENSION ARRAY (FSW)
C     PACO2          ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C     PBOVP          GAS PHASE OVERPRESSURE (FSW)
C     PH2O           PARTIAL PRESSURE OF WATER VAPOR (FSW)
C     PO2            INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
```

```
C     PVCO2           VENOUS CO2 PARTIAL PRESSURE (FSW)
C     PVO2            VENOUS O2 PARTIAL PRESSURE (FSW)
C     RATE            RATE OF TRAVEL DURING DEPTH CHANGE (FSW OR MSW/MIN)
C     SDR             SATURATION-DESATURATION HALFTIME RATIO
C     TC              TIME CHANGE DURING ASCENT (MIN)
C     TP              ARRAY TO TEMPORARILY STORE COMPARTMENT GAS TENSIONS
C
C
C     NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW=1 ATA.
C
C
C*********************************************************************
C
C*********************************************************************
C                             ************************
C                             * SUBROUTINES REQUIRED *
C                             ************************
C
C     UPDT7           UPDATES MODEL OVER A SINGLE TIME INTERVAL
C
C*********************************************************************
C
C                         MODEL INPUT VARIABLES
C     THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C     MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C     SUBROUTINES.
C
      COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                             MODEL COMMOM
C     THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C     THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
      COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
      COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
      LOGICAL CPO2,LASTIT
      REAL M
      DIMENSION TP(9)
C
C*********************************************************************
C
C                       INITIALIZATION PROCEDURE
C
C*********************************************************************
C
C     INITIALIZE DEPTH OF FIRST STOP TO CURRENT DEPTH. IF "CDEPTH" EQUAL
C     TO OR SHALLOWER THAN "IAD" FIRST STOP IS AT "CDEPTH".
C
      DFS=CDEPTH
      IF(INT(CDEPTH) .LE. IAD) RETURN
C
C     INITIALIZE "LAST ITERATION" SWITCH. SAVE TISSUE TENSIONS AND
C     "IAD" TEMPORARILY.
C
      LASTIT=.FALSE.
      DO 20 I=1,NTISS
 20   TP(I)=P(I)
      IADTMP=IAD
```

```
C
C*******************************************************************
C
C                      END OF INITIALIZATION
C
C*******************************************************************
C
C*******************************************************************
C
C                  DEPTH OF FIRST STOP ITERATION LOOP
C
C                      ALL EXITS GO TO STATEMENT #50
C
C*******************************************************************
C       TRY FIRST STOP DEPTH AS "IAD". DEFINITION OF ASCENT CRITERIA
C       REQUIRES THEY BE MET "DINC" DEEPER THAN FINAL FIRST STOP DEPTH.
C
30      MIND=IAD
        DC=MIND-CDEPTH+DINC
        TC=DC/RATE
C
C       SUBROUTINE UPDT7 WILL COMPUTE NEW "IAD" AFTER TRIAL ASCENT.
C       REESTABLISH TISSUE TENSIONS AFTER CALLING SUBROUTINE UPDT7.
C
        CALL UPDT7
        DO 32 I=1,NTISS
32      P(I)=TP(I)
C
C       IF "IAD" HASN'T CHANGED OR HAS DECREASED DURING TRIAL ASCENT TO
C       "MIND+DINC" THEN ASCENT TO "MIND" MAY BE POSSIBLE WITHOUT
C       VIOLATING THE ASCENT CRITERIA. GIVE IT A TRY. REESTABLISH TISSUE
C       TENSIONS WHEN DONE.
C
        IF(IAD .GT. MIND) GO TO 42
        DC=MIND-CDEPTH
        TC=DC/RATE
        CALL UPDT7
        DO 40 I=1,NTISS
40      P(I)=TP(I)
C
C       IF NEW "IAD" AND "MIND" EQUAL AFTER TRIAL ASCENT,  WE'RE DONE.
C
42      IF(IAD.EQ.MIND) GO TO 50
C
C       IF NEW "IAD" IS SHALLOWER THAN "MIND" SET "LASTIT" TO TRUE. THIS
C       WILL STOP THE ITERATION IF "IAD" BECOMES GREATER THAN "MIND" THE
C       NEXT TIME AROUND. THIS WILL PREVENT GETTING STUCK IN THE LOOP IF
C       THERE IS A TISSUE STILL SATURATING AT "MIND" IN WHICH CASE "IAD"
C       WILL NEVER EQUAL "MIND" BUT WILL OSCILLATE ONE DEPTH INCREMENT
C       DEEPER AND SHALLOWER ON SUCCESSIVE ITERATIONS. IN THESE CASES THE
C       FIRST STOP DEPTH IS THE FIRST VALUE OF "MIND" WHICH CAUSES "IAD"
C       TO INCREASE IN VALUE AFTER IT HAD DECREASED ON THE PREVIOUS
C       ITERATION.
C
        IF(IAD.LT.MIND) LASTIT=.TRUE.
        IF(IAD.GT.MIND .AND. LASTIT) GO TO 50
C
C       SET UP FOR ASCENT TO NEW "IAD".
C
        GO TO 30
```

```
C
C*********************************************************************
C
C                      END OF ITERATION LOOP
C
C*********************************************************************
C
C      REESTABLISH "IAD". DEPTH OF FIRST STOP IS "MIND".
C
  50   IAD=IADTMP
       DFS=MIND
       RETURN
       END
       END$
```

ANNEX B-5

SUBROUTINE STIM7
EXPONENTIAL-LINEAR VERSION
LISTING

```
&STIM7 T=00004 IS ON CR00012 USING 00055 BLKS R=0000

FTN4
      SUBROUTINE STIM7(TIME,SDEPTH), 24 SEPT 82 VER 1.4
C
C                     EXPONENTIAL-LINEAR VERSION
C
C         FINDS THE TIME WHICH NEEDS TO BE SPENT AT "CDEPTH" IN ORDER
C     TO ASCEND TO "SDEPTH". "SDEPTH" IS USED TO COMPUTE THE DEPTH (ROW)
C     SUBSCRIPT "IJ" FOR ARRAY "M". IF "SDEPTH" IS NOT AN EXACT MULTIPLE
C     OF "DINC" "IJ" POINTS TO THE NEXT SHALLOWER DEPTH WHICH IS. IN
C     ORDER TO ASCEND TO "SDEPTH" SUFFICIENT TIME MUST BE SPENT AT
C     "CDEPTH" SO THAT ALL TISSUE TENSIONS BECOME LESS THAN OR EQUAL TO
C     THE MAXIMUM TISSUE TENSIONS IN THE "IJ" ROW OF THE ARRAY "M".
C     THE NORMAL MODE IS FOR THE NEXT STOP TO BE ONE "DINC" SHALLOWER
C     THAN THE CURRENT DEPTH. WHEN THE NEXT STOP IS MORE THAN ONE "DINC"
C     SHALLOWER THE INITIALLY COMPUTED STOP TIME IS SHORTENED TO TAKE
C     ADVANTAGE OF THE ADDITIONAL DECOMPRESSION GAINED AFTER THE FIRST
C     "DINC" OF ASCENT.
C
C
C                  @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                  @                                     @
C                  @             WRITTEN BY              @
C                  @                                     @
C                  @  CDR EDWARD D. THALMANN (MC) USN    @
C                  @                                     @
C                  @                                     @
C                  @   U.S. NAVY EXPERIMENTAL DIVING     @
C                  @               UNIT                  @
C                  @   PANAMA CITY,FLORIDA      32407    @
C                  @                                     @
C                  @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C*********************************************************************
C                              *************
C                              * VARIABLES *
C                              *************
C
C     AMBAO2        AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH        CURRENT DEPTH (FSW OR MSW)
C     CF            METRIC CONVERSION FACTOR
C     CPO2          CONSTANT PARTIAL PRESSSURE O2?
C     DC            DEPTH CHANGE (FSW OR MSW)
C     DFS           DEPTH OF FIRST STOP (FSW OR MSW)
C     DINC          STOP DEPTH INCREMENTS (FSW OR MSW)
C     FIRSTM        FIRST TIME THROUGH OPTIMIZATION PROCEDURE?
C     FN2           INERT GAS FRACTION
C     HLFTM         COMPARTMENT HALFTIMES (MIN)
C     IAD           INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IADTMP        TEMPORARY IAD STORAGE
C     IDFS          HAS "DFS" EVER BEEN GREATER THAN "SDEPTH"?
C     IJ            DEPTH (ROW) SUBSCRIPT FOR ARRAY "M".
C     KDSAT         TIME CONSTANT FOR DESATURATING TISSUE (1/MIN)
C     KSAT          TIME CONSTANT FOR SATURATING TISSUES (1/MIN)
C     M             COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS         NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P             COMPARTMENT GAS TENSION ARRAY (FSW)
C     PACO2         ARTERIAL CO2 PARTIAL PRESSURE (FSW)
```

```
C     PAMB          AMBIENT PRESSURE (FSW)
C     PAN2          ARTERIAL INERT GAS TENSION (FSW)
C     PAO2          ARTERIAL O2 TENSION (FSW)
C     PBOVP         GAS PHASE OVERPRESSURE (FSW)
C     PH2O          PARTIAL PRESSURE OF WATER VAPOR (FSW)
C     PLIN          INERT GAS TENSION AT END OF LINEAR UPDATE (FSW)
C     PO2           INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C     PVCO2         VENOUS CO2 PARTIAL PRESSURE (FSW)
C     PVN2          VENOUS INERT GAS TENSION (FSW)
C     PVO2          VENOUS O2 PARTIAL PRESSURE (FSW)
C     RATE          RATE OF TRAVEL DURING DEPTH CHANGE (FSW OR MSW/MIN)
C     SDEPTH        NEXT DEPTH AFTER STOP (FSW OR MSW)
C     SDR           SATURATION-DESATURATION HALFTIME RATIO
C     T             TRIAL NO DECOMPRESSION TIME (MIN)
C     TC            TIME CHANGE DURING ASCENT (MIN)
C     TDSAT         STOP TIME FOR DESATURATING TISSUE (MIN)
C     TEXP          TIME FOR EXPONENTIAL UPDATE PORTION (MIN)
C     TIME          STOP TIME (MIN)
C     TLIN          TIME FOR LINEAR UPDATE PORTION (MIN)
C     TP            TEMPORARY GAS TENSION STORAGE ARRAY
C     TSAT          STOP TIME FOR SATURATING TISSUE (MIN)
C
C
C     NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C*********************************************************************
C
C*********************************************************************
C                             ***********************
C                             * SUBROUTINES REQUIRED *
C                             ***********************
C
C           UPDT7    UPDATES TISSUE TENSIONS, COMPUTES "IAD"
C           FRSP7    COMPUTES DEPTH OF FIRST STOP
C
C*********************************************************************
C
C                        MODEL INPUT VARIABLES
C     THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C     MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C     SUBROUTINES.
C
      COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                            MODEL COMMON
C     THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C     THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
      COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
      COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
      LOGICAL CPO2,IDFS,FIRSTM
      REAL M,K,KSAT,KDSAT,TP(9)
C
C*********************************************************************
C
C                      INITIALIZATION PROCEDURE
C
```

```
C*****************************************************************
C
C     COMPUTE AMBIENT PRESSURE IN FSW.
C
      PAMB=CDEPTH*CF+33.
C
C     IF CPO2 SET USE CONSTANT PO2 MODE FOR COMPUTING PO2. COMPUTE
C     VENOUS AND ARTERIAL INERT GAS TENSIONS.
C
      PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
      IF(CPO2) PAO2=PO2*33.*(1.0-PH2O/PAMB)-AMBAO2
      PVN2=PAMB-(PVO2+PVCO2+PH2O)+PBOVP
      PAN2=PAMB-(PAO2+PACO2+PH2O)
C
C     INITIALIZE SATURATION AND DESATURATION TIMES.
C
      TDSAT=0.0
      TSAT=9999.
C
C     COMPUTE DEPTH SUBSCRIPT FOR ARRAY "M" CORRESPONDING TO "SDEPTH".
C
      IJ=(SDEPTH/DINC)+1
C
C*****************************************************************
C
C                        END OF INITIALIZATION
C
C*****************************************************************
C
C*****************************************************************
C
C     TRIAL DESATURATION AND SATURATION STOP TIME COMPUTATION PROCEDURE
C
C     STOP TIME IS THE TIME AT WHICH TISSUE DISSOLVED INERT GAS TENSION
C     (P(I)) EQUALS THE MAXIMUM PERMISSIBLE TENSION AT THE NEXT DESIRED
C     DEPTH. AT A GIVEN STOP SOME TISSUES MAY BE SATURATING, OTHERS
C     DESATURATING. THE STOP TIME IS THE LESSER OF THE SATURATION TIME
C     AND DESATURATION TIME TO THE MAXIMUM VALUE IN ARRAY "M".
C
C*****************************************************************
C
C     COMPUTE TRIAL SATURATION OR DESATURATION STOP TIME FOR EACH TISSUE
C
      DO 300 I=1,NTISS
C
C     COMPUTE TIME CONSTANTS FOR SATURATING AND DESATURATING TISSUES.
C
      KSAT=ALOG(2.0)/HLFTM(I)
      KDSAT=KSAT*SDR(I)
C
C     IF TISSUE SATURATING GO TO SATURATION TIME COMPUTATION.
C
      IF(P(I).LE.PAN2) GO TO 100
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C           FIND TRIAL STOP TIME FOR DESATURATING TISSUES
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
```

```
C     IF TISSUE TENSION LESS THAN THE MAXIMUM PERMISSIBLE TENSION THEN
C     THE TRIAL STOP TIME IS 0.0.
C
      T=0.0
      IF(P(I).LE.M(I,IJ)) GO TO 50
C
C     IF ARTERIAL TENSION GREATER THAN MAXIMUM PERMISSIBLE TENSION THEN
C     STOP TIME IS INFINITE (9999 MIN.).
C
      T=9999.
      IF(PAN2.GE.M(I,IJ)) GO TO 50
C
C     IF TISSUE TENSION LESS THAN "PVN2" TISSUE IS ALREADY IN THE
C     EXPONENTIAL PORTION OF DESATURATION AND LINEAR PORTION OF THE
C     STOP TIME IS 0.0. THIS IS ACCOMPLISHED BY SETTING "PLIN" TO "P(I)"
C     SO "TLIN" WILL BE COMPUTED AS 0.0.
C
      IF(P(I).LE.PVN2) PLIN=P(I)
C
C     COMPUTE STOP TIME FOR THE LINEAR PORTION OF DESATURATION. "PLIN"
C     IS THE VALUE OF THE TISSUE TENSION AT THE COMPLETION OF THE LINEAR
C     DESATURATION TO THE MAXIMUM TISSUE TENSION.
C
      IF(P(I).GT.PVN2) PLIN=PVN2
      IF(M(I,IJ).GE.PVN2) PLIN=M(I,IJ)
      TLIN=(1/KDSAT)*((PLIN-P(I))/(PAN2-PVN2))
C
C     IF THE MAXIMUM TISSUE TENSION GREATER THAN "PVN2" NO EXPONENTIAL
C     DESATURATION WILL OCCUR AND EXPONENTIAL PORTION OF THE STOP TIME
C     WILL BE 0.0.
C
      TEXP=0.0
      IF(M(I,IJ).GE.PVN2) GO TO 40
C
C     COMPUTE EXPONENTIAL PORTION OF THE STOP TIME.
C
      TEXP=(1/KDSAT)*ALOG((PLIN-PAN2)/(M(I,IJ)-PAN2))
C
C     DESATURATION STOP TIME IS THE SUM OF THE EXPONENTIAL AND LINEAR
C     TIMES.
C
40    T=TLIN+TEXP
C
C     LARGEST ALLOWABLE TIME IS 9999 MIN. WHICH IS ESSENTIALLY INFINITE.
C
      IF(T.GT.9999.) T=9999.
C
C     SAVE LARGEST DESATURATION TIME COMPUTED SO FAR.
C
50    TDSAT=AMAX1(TDSAT,T)
      GO TO 300
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C             TRIAL STOP TIME COMPUTATION FOR SATURATING TISSUES
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     SATURATION TIME IS 0.0 IF TISSUE TENSION ALREADY GREATER THAN THE
C     MAXIMUM PERMISSIBLE VALUE.
```

```
C
100   T=0.0
      IF(P(I).GE.M(I,IJ)) GO TO 150
C
C     WILL NEVER REACH MAXIMUM VALUE IF ARTERIAL TENSION LESS THAN THE
C     MAXIMUM PERMISSIBLE VALUE.
C
      T=9999.
      IF(PAN2.LE.M(I,IJ)) GO TO 150
C
C     COMPUTE SATURATION TIME.
C
      T=(1/KSAT)*ALOG((P(I)-PAN2)/(M(I,IJ)-PAN2))
      IF(T.LT.0.0) T=0.0
C
C     SAVE THE SMALLEST DESATURATION TIME SO FAR THEN GO BACK AND DO
C     ANOTHER TISSUE OR DROP THROUGH IF ALL "NTISS" TISSUES DONE.
C
150   TSAT=AMIN1(T,TSAT)
300   CONTINUE
C
C*******************************************************************************
C
C                END TRIAL STOP TIME COMPUTATION PROCEDURES
C
C*******************************************************************************
C
C     TIME IS LESSER OF SATURATION AND DESATURATION TIME.
C
      TIME=AMIN1(TSAT,TDSAT)
C
C     IF NEXT DEPTH ONLY "DINC" SHALLOWER WE'RE DONE.
C
      IF((CDEPTH-SDEPTH).LE.DINC) RETURN
C
C     IF TRIAL STOP TIME 0.0 OR 9999 THEN NO OPTIMIZATION, RETURN.
C
      IF(TIME.EQ.0.0 .OR. TIME.GE.9999.) RETURN
C
C*******************************************************************************
C
C                        STOP TIME OPTIMIZATION PROCEDURE
C
C     IF ASCENDING MORE THAN ONE STOP DEPTH INCREMENT AFTER TAKING A
C     DECOMPRESSION STOP SOME ADDITIONAL TISSUE OFFGASSING MAY OCCUR
C     DURING ASCENT. IF POSSIBLE THE STOP TIME IS SHORTENED UNTIL THE
C     DEPTH OF THE FIRST STOP (DFS) AS COMPUTED BY SUBROUTINE FRSP7 IS
C     JUST EQUAL TO "SDEPTH". THIS IS DONE BY FIRST SHORTENING THE
C     STOP TIME IN 0.1 MIN. INCREMENTS UNTIL "DFS" EXCEEDS "SDEPTH" AND
C     THEN SHORTENING THE TIME IN 0.005 MIN. INCREMENTS UNTIL "DFS" JUST
C     EQUALS "SDEPTH". THE OPTIMIZED TIME IS THEN 0.005 MIN. TOO LONG AT
C     THE MOST.
C
C*******************************************************************************
C
C     INITIALIZE LOGICAL VARIABLES.
C
      IDFS=.FALSE.
      FIRSTM=.TRUE.
C
```

```
C     STORE TISSUE TENSIONS AND CURRENT "IAD" TEMPORARILY.
C
400   DO 410 I=1,NTISS
410   TP(I)=P(I)
      IADTMP=IAD
C
C     DO TRIAL UPDATE AT "CDEPTH" AND FIND DEPTH OF FIRST STOP.
C
      DC=0.0
      TC=TIME
      CALL UPDT7
      CALL FRSP7(DFS)
C
C     RESTORE TISSUE TENSIONS AND "IAD".
C
      DO 420 I=1,NTISS
420   P(I)=TP(I)
      IAD=IADTMP
C
C     IF FIRST STOP BELOW "SDEPTH" TRIAL STOP TIME MAY BE TOO SHORT.
C
      IF(DFS.GT.SDEPTH) GO TO 430
C
C     "FIRSTM" SET TO FALSE AFTER FIRST PASS.
C
      FIRSTM=.FALSE.
C
C     IF "IDFS" HAS BEEN SET TO TRUE BY THE PROCEDURE BELOW WE'RE DONE
C     AS SOON AS "DFS" EQUALS "SDEPTH". WE'RE ALSO DONE IF THE TRIAL
C     STOP TIME HAS DECREASED TO 0.0.
C
      IF(IDFS .OR. TIME.EQ.0.0) RETURN
C
C     SUBTRACT TIME IN 0.1 MIN INCREMENTS AND REPEAT TRIAL UPDATE UNTIL
C     "DFS" JUST EQUALS "SDEPTH". TIMES LESS THAN 0.0 NOT ALLOWED.
C
      TIME=AMAX1((TIME-0.1),0.0)
      GO TO 400
C
C     IF WE END UP HERE THE FIRST IME THROUGH OPTIMIZATION NOT POSSIBLE.
C     AFTER FIRST TIME THROUGH SET "FIRSTM" TO FALSE.
C
430   IF(FIRSTM) RETURN
      FIRSTM=.FALSE.
C
C     INCREASE TIME IN 0.005 MIN INCREMENTS UNTIL FIRST STOP DEPTH
C     DECREASES TO "SDEPTH". SETTING "IDFS" TO TRUE CAUSES EXIT FROM THE
C     ITERATION AS SOON AS THIS HAPPENS.
C
      TIME=TIME+0.005
      IDFS=.TRUE.
      GO TO 400
C
C*****************************************************************
C
C                 END OF STOP TIME OPTIMIZATION PROCEDURE
C
C*****************************************************************
      END
      END$
```

ANNEX B-6

SUBROUTINE STIM7
EXPONENTIAL-EXPONENTIAL VERSION
LISTING

&STIME T=00004 IS ON CR00012 USING 00051 BLKS R=0000

```
FTN4
      SUBROUTINE STIM7(TIME,SDEPTH), 24 SEPT 82 VER 2.1
C
C                   EXPONENTIAL-EXPONENTIAL VERSION
C
C         FINDS THE TIME WHICH NEEDS TO BE SPENT AT "CDEPTH" IN ORDER
C     TO ASCEND TO "SDEPTH". "SDEPTH" IS USED TO COMPUTE THE DEPTH (ROW)
C     SUBSCRIPT "IJ" FOR ARRAY "M". IF "SDEPTH" IS NOT AN EXACT MULTIPLE
C     OF "DINC" "IJ" POINTS TO THE NEXT SHALLOWER DEPTH WHICH IS. IN
C     ORDER TO ASCEND TO "SDEPTH" SUFFICIENT TIME MUST BE SPENT AT
C     "CDEPTH" SO THAT ALL TISSUE TENSIONS BECOME LESS THAN OR EQUAL TO
C     THE MAXIMUM TISSUE TENSIONS IN THE "IJ" ROW OF THE ARRAY "M".
C     THE NORMAL MODE IS FOR THE NEXT STOP TO BE ONE "DINC" SHALLOWER
C     THAN THE CURRENT DEPTH. WHEN THE NEXT STOP IS MORE THAN ONE "DINC"
C     SHALLOWER THE INITIALLY COMPUTED STOP TIME IS SHORTENED TO TAKE
C     ADVANTAGE OF THE ADDITIONAL DECOMPRESSION GAINED AFTER THE FIRST
C     "DINC" OF ASCENT.
C
C
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                 @                                      @
C                 @              WRITTEN BY              @
C                 @                                      @
C                 @   CDR EDWARD D. THALMANN (MC) USN    @
C                 @                                      @
C                 @                                      @
C                 @   U.S. NAVY EXPERIMENTAL DIVING      @
C                 @               UNIT                   @
C                 @   PANAMA CITY,FLORIDA     32407      @
C                 @                                      @
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C**********************************************************************
C                              *************
C                              * VARIABLES *
C                              *************
C
C     AMBAO2        AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH        CURRENT DEPTH (FSW OR MSW)
C     CF            METRIC CONVERSION FACTOR
C     CPO2          CONSTANT PARTIAL PRESSSURE O2?
C     DC            DEPTH CHANGE (FSW OR MSW)
C     DFS           DEPTH OF FIRST STOP (FSW OR MSW)
C     DINC          STOP DEPTH INCREMENTS (FSW OR MSW)
C     FIRSTM        FIRST TIME THROUGH OPTIMIZATION PROCEDURE?
C     FN2           INERT GAS FRACTION
C     HLFTM         COMPARTMENT HALFTIMES (MIN)
C     IAD           INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IADTMP        TEMPORARY IAD STORAGE
C     IDFS          HAS "DFS" EVER BEEN GREATER THAN "SDEPTH"?
C     IJ            DEPTH (ROW) SUBSCRIPT FOR ARRAY "M".
C     KDSAT         TIME CONSTANT FOR DESATURATING TISSUE (1/MIN)
C     KSAT          TIME CONSTANT FOR SATURATING TISSUES (1/MIN)
C     M             COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS         NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P             COMPARTMENT GAS TENSION ARRAY (FSW)
```

```
C      PACO2          ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C      PAMB           AMBIENT PRESSURE (FSW)
C      PAN2           ARTERIAL INERT GAS TENSION (FSW)
C      PAO2           ARTERIAL O2 TENSION (FSW)
C      PBOVP          GAS PHASE OVERPRESSURE (FSW)
C      PH2O           PARTIAL PRESSURE OF WATER VAPOR (FSW)
C      PLIN           INERT GAS TENSION AT END OF LINEAR UPDATE (FSW)
C      PO2            INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C      PVCO2          VENOUS CO2 PARTIAL PRESSURE (FSW)
C      PVO2           VENOUS O2 PARTIAL PRESSURE (FSW)
C      RATE           RATE OF TRAVEL DURING DEPTH CHANGE (FSW OR MSW/MIN)
C      SDEPTH         NEXT DEPTH AFTER STOP (FSW OR MSW)
C      SDR            SATURATION-DESATURATION HALFTIME RATIO
C      T              TRIAL NO DECOMPRESSION TIME (MIN)
C      TC             TIME CHANGE DURING ASCENT (MIN)
C      TDSAT          STOP TIME FOR DESATURATING TISSUE (MIN)
C      TIME           STOP TIME (MIN)
C      TP             TEMPORARY GAS TENSION STORAGE ARRAY
C      TSAT           STOP TIME FOR SATURATING TISSUE (MIN)
C
C
C      NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C**********************************************************************
C
C**********************************************************************
C                               **********************
C                               * SUBROUTINES REQUIRED *
C                               **********************
C
C           UPDT7    UPDATES TISSUE TENSIONS, COMPUTES "IAD"
C           FRSP7    COMPUTES DEPTH OF FIRST STOP
C
C**********************************************************************
C
C                        MODEL INPUT VARIABLES
C      THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C      MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C      SUBROUTINES.
C
       COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                           MODEL COMMON
C      THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C      THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
       COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
       COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
       LOGICAL CPO2,IDFS,FIRSTM
       REAL M,K,KSAT,KDSAT,TP(9)
C
C**********************************************************************
C
C                    INITIALIZATION PROCEDURE
C
C**********************************************************************
C
```

```
C     COMPUTE AMBIENT PRESSURE IN FSW.
C
      PAMB=CDEPTH*CF+33.
C
C     IF CPO2 SET USE CONSTANT PO2 MODE FOR COMPUTING PO2. COMPUTE
C     ARTERIAL INERT GAS TENSION.
C
      PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
      IF(CPO2) PAO2=PO2*33.*(1.0-PH2O/PAMB)-AMBAO2
      PAN2=PAMB-(PAO2+PACO2+PH2O)
C
C     INITIALIZE SATURATION AND DESATURATION TIMES.
C
      TDSAT=0.0
      TSAT=9999.
C
C     COMPUTE DEPTH SUBSCRIPT FOR ARRAY "M" CORRESPONDING TO "SDEPTH".
C
      IJ=(SDEPTH/DINC)+1
C
C*****************************************************************
C
C                      END OF INITIALIZATION
C
C*****************************************************************
C
C*****************************************************************
C
C     TRIAL DESATURATION AND SATURATION STOP TIME COMPUTATION PROCEDURE
C
C     STOP TIME IS THE TIME AT WHICH TISSUE DISSOLVED INERT GAS TENSION
C     (P(I)) EQUALS THE MAXIMUM PERMISSIBLE TENSION AT THE NEXT DESIRED
C     DEPTH. AT A GIVEN STOP SOME TISSUES MAY BE SATURATING, OTHERS
C     DESATURATING. THE STOP TIME IS THE LESSER OF THE SATURATION TIME
C     AND DESATURATION TIME TO THE MAXIMUM VALUE IN ARRAY "M".
C
C*****************************************************************
C
C     COMPUTE TRIAL SATURATION OR DESATURATION STOP TIME FOR EACH TISSUE
C
      DO 300 I=1,NTISS
C
C     COMPUTE TIME CONSTANTS FOR SATURATING AND DESATURATING TISSUES.
C
      KSAT=ALOG(2.0)/HLFTM(I)
      KDSAT=KSAT*SDR(I)
C
C     IF TISSUE SATURATING GO TO SATURATION TIME COMPUTATION.
C
      IF(P(I).LE.PAN2) GO TO 100
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C          FIND TRIAL STOP TIME FOR DESATURATING TISSUES
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     IF TISSUE TENSION LESS THAN THE MAXIMUM PERMISSIBLE TENSION THEN
C     THE TRIAL STOP TIME IS 0.0.
C
```

```
      T=0.0
      IF(P(I).LE.M(I,IJ)) GO TO 50
C
C     IF ARTERIAL TENSION GREATER THAN MAXIMUM PERMISSIBLE TENSION THEN
C     STOP TIME IS INFINITE (9999 MIN.).
C
      T=9999.
      IF(PAN2.GE.M(I,IJ)) GO TO 50
C
C     COMPUTE SATURATION STOP TIME.
C
      T=(1/KDSAT)*ALOG((P(I)-PAN2)/(M(I,IJ)-PAN2))
C
C     LARGEST ALLOWABLE TIME IS 9999 MIN. WHICH IS ESSENTIALLY INFINITE.
C
      IF(T.GT.9999.) T=9999.
C
C     SAVE LARGEST DESATURATION TIME COMPUTED SO FAR.
C
50    TDSAT=AMAX1(TDSAT,T)
      GO TO 300
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C             TRIAL STOP TIME COMPUTATION FOR SATURATING TISSUES
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     SATURATION TIME IS 0.0 IF TISSUE TENSION ALREADY GREATER THAN THE
C     MAXIMUM PERMISSIBLE VALUE.
C
100   T=0.0
      IF(P(I).GE.M(I,IJ)) GO TO 150
C
C     WILL NEVER REACH MAXIMUM VALUE IF ARTERIAL TENSION LESS THAN THE
C     MAXIMUM PERMISSIBLE VALUE.
C
      T=9999.
      IF(PAN2.LE.M(I,IJ)) GO TO 150
C
C     COMPUTE SATURATION TIME.
C
      T=(1/KSAT)*ALOG((P(I)-PAN2)/(M(I,IJ)-PAN2))
      IF(T.LT.0.0) T=0.0
C
C     SAVE THE SMALLEST DESATURATION TIME SO FAR.
C
150   TSAT=AMIN1(T,TSAT)
C
C     END OF LOOP. GO BACK AND DO ANOTHER TISSUE OR DROP THROUGH IF ALL
C     "NTISS" TISSUES DONE.
C
300   CONTINUE
C
C***********************************************************************
C
C               END TRIAL STOP TIME COMPUTATION PROCEDURES
C
C***********************************************************************
C
```

```
C       TIME IS LESSER OF SATURATION AND DESATURATION TIME.
C
        TIME=AMIN1(TSAT,TDSAT)
C
C       IF NEXT DEPTH ONLY "DINC" SHALLOWER WE'RE DONE.
C
        IF((CDEPTH-SDEPTH).LE.DINC) RETURN
C
C       IF TRIAL STOP TIME 0.0 OR 9999 THEN NO OPTIMIZATION, RETURN.
C
        IF(TIME.EQ.0.0 .OR. TIME.GE.9999.) RETURN
C
C*************************************************************************
C
C                            STOP TIME OPTIMIZATION PROCEDURE
C
C       IF ASCENDING MORE THAN ONE STOP DEPTH INCREMENT AFTER TAKING A
C       DECOMPRESSION STOP SOME ADDITIONAL TISSUE OFFGASSING MAY OCCUR
C       DURING ASCENT. IF POSSIBLE THE STOP TIME IS SHORTENED UNTIL THE
C       DEPTH OF THE FIRST STOP (DFS) AS COMPUTED BY SUBROUTINE FRSP7 IS
C       JUST EQUAL TO "SDEPTH". THIS IS DONE BY FIRST SHORTENING THE
C       STOP TIME IN 0.1 MIN. INCREMENTS UNTIL "DFS" EXCEEDS "SDEPTH" AND
C       THEN SHORTENING THE TIME IN 0.005 MIN. INCREMENTS UNTIL "DFS" JUST
C       EQUALS "SDEPTH". THE OPTIMIZED TIME IS THEN 0.005 MIN. TOO LONG AT
C       THE MOST.
C
C*************************************************************************
C
C       INITIALIZE LOGICAL VARIABLES.
C
        IDFS=.FALSE.
        FIRSTM=.TRUE.
C
C       STORE TISSUE TENSIONS AND CURRENT "IAD" TEMPORARILY.
C
400     DO 410 I=1,NTISS
410     TP(I)=P(I)
        IADTMP=IAD
C
C       DO TRIAL UPDATE AT "CDEPTH" AND FIND DEPTH OF FIRST STOP.
C
        DC=0.0
        TC=TIME
        CALL UPDT7
        CALL FRSP7(DFS)
C
C       RESTORE TISSUE TENSIONS AND "IAD".
C
        DO 420 I=1,NTISS
420     P(I)=TP(I)
        IAD=IADTMP
C
C       IF FIRST STOP BELOW "SDEPTH" TRIAL STOP TIME MAY BE TOO SHORT.
C
        IF(DFS.GT.SDEPTH) GO TO 430
C
C       "FIRSTM" SET TO FALSE AFTER FIRST PASS.
C
        FIRSTM=.FALSE.
C
```

```
C     IF "IDFS" HAS BEEN SET TO TRUE BY THE PROCEDURE BELOW WE'RE DONE
C     AS SOON AS "DFS" EQUALS "SDEPTH". WE'RE ALSO DONE IF THE TRIAL
C     STOP TIME HAS DECREASED TO 0.0.
C
      IF(IDFS .OR. TIME.EQ.0.0) GO TO 440
C
C     SUBTRACT TIME IN 0.1 MIN INCREMENTS AND REPEAT TRIAL UPDATE UNTIL
C     "DFS" JUST EQUALS "SDEPTH". TIMES LESS THAN 0.0 NOT ALLOWED.
C
      TIME=AMAX1((TIME-0.1),0.0)
      GO TO 400
C
C     IF WE END UP HERE THE FIRST IME THROUGH OPTIMIZATION NOT POSSIBLE.
C     AFTER FIRST TIME THROUGH SET "FIRSTM" TO FALSE.
C
430   IF(FIRSTM) RETURN
      FIRSTM=.FALSE.
C
C     INCREASE TIME IN 0.005 MIN INCREMENTS UNTIL FIRST STOP DEPTH
C     DECREASES TO "SDEPTH". SETTING "IDFS" TO TRUE CAUSES EXIT FROM THE
C     ITERATION AS SOON AS THIS HAPPENS.
C
      TIME=TIME+0.005
      IDFS=.TRUE.
      GO TO 400
C
C**********************************************************************
C
C                END OF STOP TIME OPTIMIZATION PROCEDURE
C
C**********************************************************************
C
C     EXIT SUBROUTINE.
C
440   RETURN
      END
      END$
```

ANNEX B-7

SUBROUTINE NLIM7
LISTING

```
&NLIM7 T=00004 IS ON CR00013 USING 00038 BLKS R=0000

FTN4
      SUBROUTINE NLIM7(TIME), 24 SEPT 82 VER 1.2
C
C
C         FINDS THE NO-DECOMPRESSION TIME AT "CDEPTH" BY FIRST COMPUTING
C     A TRIAL TIME WHICH IS THE SHORTEST TIME IT TAKES ANY OF THE TISSUE
C     COMPARTMENTS TO SATURATE TO ITS MAXIMUM SURFACING TENSION. THIS
C     TIME IS THEN OPTIMIZED TO FIND THE LONGEST TIME WHICH CAN BE SPENT
C     AT "CDEPTH" WHICH WILL ALLOW ASCENT TO THE SURFACE AT "RATE".(NOTE
C     THAT THE TRIAL TIME ASSUMED INSTATANEOUS ASCENT.) OPTIMIZATION IS
C     ACCOMPLISHED BY USING SUBROUTINE FRSP7 TO FIND THE DEPTH OF THE
C     FIRST STOP AFTER A TRIAL TISSUE UPDATE AT "CDEPTH" FOR THE TRIAL
C     NO-D TIME. THE TRIAL NO-D TIME IS INCREASED IN 0.1 MIN INCREMENTS
C     UNTIL THE FIRST STOP DEPTH INCREASES TO "DINC".(THIS ENSURES THAT
C     THE TRIAL TIME IS NOT TO SHORT.) ONCE THIS IS DONE THE NO-D TRIAL
C     TIME IS DECREASED IN 0.005 MIN INCREMENTS UNTIL THE FIRST STOP
C     JUST DECREASES TO ZERO AGAIN. AT THIS POINT THE FINAL NO-D TIME IS
C     AT THE WORST 0.005 MIN TOO LONG.
C
C
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                 @                                   @
C                 @             WRITTEN BY            @
C                 @                                   @
C                 @  CDR EDWARD D. THALMANN (MC) USN  @
C                 @                                   @
C                 @                                   @
C                 @   U.S. NAVY EXPERIMENTAL DIVING   @
C                 @               UNIT                @
C                 @   PANAMA CITY,FLORIDA     32407   @
C                 @                                   @
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*********************************************************************
C                              ************
C                              * VARIABLES *
C                              ************
C
C     A              INTERMEDIATE RATIO USED IN COMPUTING "T"
C     AMBAO2         AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH         CURRENT DEPTH
C     CF             METRIC CONVERSION FACTOR
C     CPO2           CONSTANT PARTIAL PRESSSURE O2?
C     DC             DEPTH CHANGE
C     DFS            DEPTH OF FIRST STOP
C     DINC           STOP DEPTH INCREMENTS
C     FN2            INERT GAS FRACTION
C     HLFTM          COMPARTMENT HALFTIMES (MIN)
C     IAD            INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     IADTMP         VARIABLE TO TEMORARILY STORE CURRENT VALUE OF "IAD".
C     IDFS           HAS "DFS" EVER INCREASED TO "DINC"?
C     M              COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS          NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P              COMPARTMENT GAS TENSION ARRAY (FSW)
C     PACO2          ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C     PAMB           AMBIENT PRESSURE (FSW)
```

```
C      PAN2          ARTERIAL INERT GAS TENSION (FSW)
C      PAO2          ARTERIAL O2 TENSION (FSW)
C      PBOVP         GAS PHASE OVERPRESSURE (FSW)
C      PH2O          PARTIAL PRESSURE OF WATER VAPOR (FSW)
C      PO2           INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C      PVCO2         VENOUS CO2 PARTIAL PRESSURE (FSW)
C      PVO2          VENOUS O2 PARTIAL PRESSURE (FSW)
C      RATE          RATE OF TRAVEL DURING DEPTH CHANGE
C      SDR           SATURATION-DESATURATION HALFTIME RATIO
C      T             TRIAL NO DECOMPRESSION TIME (MIN)
C      TC            TIME CHANGE DURING ASCENT (MIN)
C      TIME          NO DECOMPRESSION TIME (MIN)
C      TP            ARRAY TO TEMPORARILY STORE COMPARTMENT GAS TENSIONS
C
C
C      NOTE: FOR PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW=1 ATA.
C
C
C**********************************************************************
C
C**********************************************************************
C                           ***********************
C                           * SUBROUTINES REQUIRED *
C                           ***********************
C
C      FRSP7         COMPUTES DEPTH OF FIRST STOP
C      UPDT7         UPDATES MODEL OVER A SINGLE TIME INTERVAL
C
C**********************************************************************
C
C                         MODEL INPUT VARIABLES
C      THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C      MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C      SUBROUTINES.
C
       COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                            MODEL COMMON
C      THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C      THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
       COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
       COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
       LOGICAL CPO2,IDFS
       REAL M
       DIMENSION TP(9)
C
C**********************************************************************
C
C                     INITIALIZATION PROCEDURE
C
C**********************************************************************
C
       IDFS=.FALSE.
       PAMB=CDEPTH*CF+33.
       PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
C
C      IF CPO2 SET USE CONSTANT PO2 MODE
```

```
C
      IF(CPO2) PAO2=PO2*33.*(1.0-PH2O/PAMB)-AMBAO2
      PAN2=PAMB-(PAO2+PACO2+PH2O)
C
C     START BY ASSUMING NO DECOMPRESSION TIME ESSENTIALLY INFINITE.
C
      TIME=9999.
C
C*********************************************************************
C
C                          END OF INITIALIZATION
C
C*********************************************************************
C
C*********************************************************************
C
C               TRIAL NO-DECOMPRESSION TIME COMPUTATION PROCEDURE
C
C     FIND TIME REQUIRED FOR EACH TISSUE TO SATURATE TO ITS MAXIMUM
C     SURFACING TENSION "M(I,1)". TRIAL NO DECOMPRESSION TIME IS THE
C     SHORTEST TIME FOR ANY TISSUE TO REACH THIS VALUE.
C
C*********************************************************************
C
      DO 10 I=1,NTISS
C
C     IF TISSUE TENSION GREATER THAN SURFACING MAX. , NO-DECOMPRESSION
C     TIME IS 0.0 .
C
      T=0.0
      IF(P(I).GE.M(I,1)) GO TO 9
C
C     IF ARTERIAL INERT GAS TENSION LESS THAN SURFACING MAX. TISSUE CAN
C     SATURATE AT "CDEPTH" AND STILL BE WITHIN NO-DECOMPRESSION LIMITS.
C
      T=9999.
      IF(PAN2 .LE.M(I,1))GO TO 9
C
C     COMPUTE "A". SHOULD NEVER BE LESS THAN 1.0 UNLESS ROUNDOFF ERROR.
C
      A=(P(I)-PAN2)/(M(I,1)-PAN2)
      IF(A.LT.1.0) A=1.0
C
C     COMPUTE "T" FOR THIS TISSUE, SAVE SHORTEST TIME COMPUTED SO FAR.
C
      T=(HLFTM(I)/ALOG(2.))*ALOG(A)
9     TIME=AMIN1(TIME,T)
10    CONTINUE
C
C*********************************************************************
C
C     DONE FINDING TRIAL MINIMUM SATURATION TIME
C
C*********************************************************************
C
C     STORE CURRENT "IAD" TEMPORARILY.
C
      IADTMP=IAD
C
C     IF "TIME" IS 9999. OR 0.0 NO OPTIMIZATION POSSIBLE, DONE.
```

```
C
      IF(TIME.GE.9999. .OR. TIME.EQ.0.0) GO TO 40
C
C*****************************************************************
C
C              NO-DECOMPRESSION TIME OPTIMIZATION PROCEDURE
C
C     DO TRIAL TISSUE UPDATE AT "CDEPTH". FIND THE DEPTH OF THE FIRST
C     STOP, ADJUST TRIAL NO-D TIME AND CONTINUE ITERATING UNTIL LONGEST
C     POSSIBLE NO-D TIME FOUND.
C
C*****************************************************************
C
C     STORE TISSUE TENSIONS TEMPORARILY IN ARRAY "TP".
C
15    DO 16 I=1,NTISS
16    TP(I)=P(I)
C
C     DO TRIAL UPDATE AT "CDEPTH" AND FIND DEPTH OF FIRST STOP.
C
      DC=0.0
      TC=TIME
      CALL UPDT7
      CALL FRSP7(DFS)
C
C     RESTORE TISSUE TENSIONS
C
      DO 25 I=1,NTISS
25    P(I)=TP(I)
C
C     IF FIRST STOP AT OR BELOW "DINC" TRIAL NO-D TIME TOO LONG.
C
      IF(DFS .GE. DINC ) GO TO 30
C
C     ADD TIME IN 0.1 MIN INCREMENTS UNTIL FIRST STOP DEPTH INCREASES TO
C     "DINC". THEN REPEAT TRIAL UPDATE. IF "IDFS" HAS BEEN SET TO TRUE
C     BY PROCEDURE BELOW THEN WE'RE DONE.
C
C
      IF(IDFS) GO TO 40
      TIME=TIME+0.1
      GO TO 15
C
C     DECREASE TIME IN 0.005 MIN INCREMENTS UNTIL FIRST STOP DEPTH
C     DECREASES TO 0. SETTING "IDFS" TO TRUE CAUSES EXIT FROM ITERATION
C     AS SOON AS THIS HAPPENS. NEGATIVE TIMES NOT ALLOWED.
C
30    IDFS=.TRUE.
      TIME=AMAX1((TIME-0.005),0.0)
C
C     IF "TIME" HAS DECREASED TO ZERO NO-D NOT POSSIBLE, DONE.
C
      IF(TIME.EQ.0.0) GO TO 40
      GO TO 15
C
C*****************************************************************
C
C     END OF NO-DECOMPRESSION TIME OPTIMIZATION PROCEDURE
C
C*****************************************************************
```

```
C
C     RESTORE "IAD" AND EXIT.
C
 40   IAD=IADTMP
      RETURN
      END
      END$
```

ANNEX B-8

SUBROUTINE INIT7
LISTING

&INIT7 T=00004 IS ON CR00012 USING 00018 BLKS R=0000

```
FTN4
      SUBROUTINE INIT7 , 24 SEPT 82 VER 1.1
C
C
C     INITIALIZES TISSUE TENSIONS BY SATURATING THEM AT "CDEPTH".
C
C
C                      @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                      @                                     @
C                      @              WRITTEN BY             @
C                      @                                     @
C                      @  CDR EDWARD D. THALMANN (MC) USN    @
C                      @                                     @
C                      @                                     @
C                      @   U.S. NAVY EXPERIMENTAL DIVING     @
C                      @             UNIT                    @
C                      @   PANAMA CITY,FLORIDA      32407    @
C                      @                                     @
C                      @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*********************************************************************
C                                  ************
C                                  * VARIABLES *
C                                  ************
C
C     AMBAO2        AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH        CURRENT DEPTH
C     CF            METRIC CONVERSION FACTOR
C     CPO2          CONSTANT PARTIAL PRESSSURE O2?
C     DC            DEPTH CHANGE
C     DINC          STOP DEPTH INCREMENTS
C     FN2           INERT GAS FRACTION
C     HLFTM         COMPARTMENT HALFTIMES (MIN)
C     IAD           INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     M             COMPARTMENT MAXIMUM GAS TENSION ARRAY (FSW)
C     NTISS         NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P             COMPARTMENT GAS TENSION ARRAY (FSW)
C     PACO2         ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C     PAMB          AMBIENT PRESSURE (FSW)
C     PAO2          ARTERIAL O2 TENSION (FSW)
C     PBOVP         GAS PHASE OVERPRESSURE (FSW)
C     PH2O          PARTIAL PRESSURE OF WATER VAPOR (FSW)
C     PO2           INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C     PVCO2         VENOUS CO2 PARTIAL PRESSURE (FSW)
C     PVO2          VENOUS O2 PARTIAL PRESSURE (FSW)
C     RATE          RATE OF TRAVEL DURING DEPTH CHANGE
C     SDR           SATURATION-DESATURATION HALFTIME RATIO
C     TC            TIME CHANGE DURING ASCENT (MIN)
C
C
C     NOTE: ALL PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C*********************************************************************
C
C*********************************************************************
```

```
C                            **********************
C                            * SUBROUTINES REQUIRED *
C                            **********************
C
C                                     NONE
C
C*************************************************************************
C
C                          MODEL INPUT VARIABLES
C      THESE ARE THE ONLY VARIABLES SENT FROM THE MAIN PROGRAM TO THE
C      MODEL SUBROUTINES. THIS COMMON STATEMENT MUST APPEAR IN ALL MODEL
C      SUBROUTINES.
C
       COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
C
C                              MODEL COMMOM
C      THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C      THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
       COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
       COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
       LOGICAL CPO2
       REAL M
C
C*************************************************************************
C
C                        BEGIN INITIALIZATION
C
C*************************************************************************
C
C      COMPUTE AMBIENT PRESSURE AND ARTERIAL O2 PARTIAL PRESSURE.
C
       PAMB= CDEPTH*CF+33.
       PAO2=(PAMB-PH2O)*(1-FN2)-AMBAO2
       IF(CPO2) PAO2=PO2*33.*(1.0-PH2O/PAMB)-AMBAO2
C
C      SATURATE ALL COMPARTMENTS AT "CDEPTH".
C
       DO 100 I=1,NTISS
100    P(I)=PAMB-(PAO2+PACO2+PH2O)
       RETURN
C
C*************************************************************************
C
C                        END OF INITIALIZATION
C
C*************************************************************************
       END
       END$
```

ANNEX B-9

SUBROUTINE RCRD7
LISTING

```
&RCRD7 T=00004 IS ON CR00013 USING 00021 BLKS R=0000

FTN4
      SUBROUTINE RCRD7(MODE,CNTR,LP), 24 SEPT 82 VER 1.1
C
C
C     RECORDS TISSUE TENSIONS, ZERO TIME AND GAS TENSION IN ARRAY "TT"
C     FOR LATER PRINTOUT. WILL ALSO PRINT ARRAY "TT".
C
C
C                    @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                    @                                    @
C                    @            WRITTEN BY              @
C                    @                                    @
C                    @  CDR EDWARD D. THALMANN (MC) USN   @
C                    @                                    @
C                    @                                    @
C                    @   U.S. NAVY EXPERIMENTAL DIVING    @
C                    @              UNIT                  @
C                    @   PANAMA CITY,FLORIDA     32407    @
C                    @                                    @
C                    @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*********************************************************************
C                               *************
C                               * VARIABLES *
C                               *************
C
C     CDEPTH         CURRENT DEPTH
C     CF             METRIC CONVERSION FACTOR
C     CPO2           CONSTANT PARTIAL PRESSSURE O2?
C     CNTR           ARRAY "TT" SUSCRIPT
C     DC             DEPTH CHANGE
C     DINC           STOP DEPTH INCREMENTS
C     FN2            INERT GAS FRACTION
C     HLFTM          COMPARTMENT HALFTIMES (MIN)
C     IAD            INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C     LP             DEVICE NUMBER OF LINE PRINTER
C     M              COMPARTMENT MAXIMUN GAS TENSION ARRAY (FSW)
C     MODE           IF "0" RECORD, IF "1" PRINTOUT
C     NTISS          NUMBER OF HALFTIME COMPARTMENTS (9 MAX.)
C     P              COMPARTMENT GAS TENSION ARRAY (FSW)
C     PO2            INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C     RATE           RATE OF TRAVEL DURING DEPTH CHANGE
C     SDR            SATURATION-DESATURATION HALFTIME RATIO
C     TC             TIME CHANGE DURING ASCENT (MIN)
C     TT             MODEL PROFILE PARAMETER ARRAY
C
C
C     NOTE: ALL PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C*********************************************************************
C
C*********************************************************************
C                         ************************
C                         * SUBROUTINES REQUIRED *
C                         ************************
```

```
C
C                                    NONE
C
C*****************************************************************************
C
C
C                        MODEL INPUT VARIABLES
C       THESE VARIABLES ARE SENT BETWEEN MODEL SUBROUTINES ONLY.
C       THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
        COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
        COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
C
C
        LOGICAL CPO2
        REAL M,TT(11,100)
        INTEGER CNTR
C
        DATA TT/1100*0.0/
C
 1      FORMAT(9F13.5,2F8.2)
 2      FORMAT(/,9(6X,I3" MIN")/
       *9(5X,F4.2" SDR"),4X,"TIME"4X"GAS"/)
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                                    BEGIN
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C       IF "MODE" IS 1 GO TO OUTPUT PROCEDURE.
C
        IF(MODE .EQ.1) GO TO 200
C
C*****************************************************************************
C
C                          RECORDING PROCEDURE
C
C       AUTOMATICALLY INCREMENTS "CNTR" EACH TIME AN ENTRY INTO ARRAY "TT"
C       IS MADE.
C
C*****************************************************************************
C
C       RECORD TISSUE TENSIONS
C
        DO 100 I=1,NTISS
 100    TT(I,CNTR)=P(I)
C
C       RECORD ZERO TIME. ZERO TIME FOR FIRST ENTRY (CNTR=1) IS 0.
C
        IF(CNTR.EQ.1) GO TO 110
        TT(10,CNTR)=TC+TT(10,CNTR-1)
C
C       RECORD GAS TENSION. VALUE DEPENDS OF WHETHER CONSTANT PO2
C       CONSTANT INERT GAS TENSION BEING USED.
C
 110    TT(11,CNTR)=FN2*100.
        IF( CPO2 ) TT(11,CNTR)=PO2
C
C       INCREMENT COUNTER TO NEXT ENTRY POSITION BEFORE RETURNING.
```

```
C
      CNTR=CNTR+1
      RETURN
C
C**********************************************************************
C
C                        END RECORDING PROCEDURE
C
C**********************************************************************
C
C**********************************************************************
C
C                          PRINTOUT PROCEDURE
C
C     PRINTOUT ARRAY "TT" THEN RETURN.
C
C**********************************************************************
C
200   WRITE(LP,2) HLFTM,SDR
      DO 210 J=1,CNTR-1
210   WRITE(LP,1)(TT(I,J),I=1,11)
      RETURN
C
C**********************************************************************
C
C                        END PRINTOUT PROCEDURE
C
C**********************************************************************
      END
      END$
```

ANNEX B-10

SUBROUTINE RDIN7
LISTING

```
&RDIN7 T=00004 IS ON CR00012 USING 00038 BLKS R=0000

FTN4
      SUBROUTINE RDIN7(LU,LP,IFILE,METRIC,IGAS,IPRT), 24 SEPT 82 VER 1.1
C
C
C
C     READS IN SUB-FILE OF MODEL INPUT PARAMETER FILE "IFILE" CONTAINING
C     MODEL PARAMETERS IN THE SPECIFIED DEPTH UNITS AND STOP DEPTH
C     INCREMENTS. PRINTS OUT MODEL INPUT PARAMETERS AND THE VALUES
C     IN COMMON BLOCK "BLDVL" IF DESIRED.
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                   @
C                   @             WRITTEN BY            @
C                   @                                   @
C                   @  CDR EDWARD D. THALMANN (MC) USN  @
C                   @                                   @
C                   @                                   @
C                   @   U.S. NAVY EXPERIMENTAL DIVING   @
C                   @               UNIT                @
C                   @   PANAMA CITY,FLORIDA     32407   @
C                   @                                   @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C*********************************************************************
C                                     *************
C                                     * VARIABLES *
C                                     *************
C
C         *         VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C                   OPERATING SYSTEM
C
C
C     AMBAO2        AMBIENT-ARTERIAL OXYGEN GRADIENT (FSW)
C     CDEPTH        CURRENT DEPTH
C     CF            METRIC CONVERSION FACTOR
C     CPO2          CONSTANT PARTIAL PRESSSURE O2?
C     DC            DEPTH CHANGE
C     DINC          STOP DEPTH INCREMENTS
C     FN2           INERT GAS FRACTION
C     HLFTM         TISSUE HALFTIMES (MIN)
C     IAD           INSTANTANEOUS ASCENT DEPTH (FSW OR MSW)
C    *IBUF          MEMORY ARRAY FOR HOLDING DISK FILE DATA
C    *IDCB          INPUT BUFFER ASSOCIATED WITH DISK FILE "IFILE"
C     IDINC         INTEGERIZED VALUE OF "DINC"
C     IDPTH         INTEGERIZED DEPTH
C    *IERR          RTE IV-B OPERATING SYSTEM ERROR CODE
C     IFILE         INPUT FILE NAME
C     IGAS          ARRAY FOR HOLDING INERT GAS LABEL
C    *IL            SPECIFIED NUMER OF CHARACTERS TO BE READ FROM FILE
C     IMODE         DEPTH UNITS DESIRED BY CALLING PROGRAM
C     INCR          STOP DEPTH INCREMENT OF MODEL PARAMETER SUB-FILE
C     IPRT          PRINTOUT DESIRED IF=1
C    *LEN           ACTUAL NUMBER OF CHARACTERS READ FROM DISK FILE
C     LP            DEVICE NUMBER OF LINE PRINTER
C     LU            DEVICE NUMBER OF TERMINAL
```

```
C      M               MAXIMUM TISSUE GAS TENSION ARRAY (FSW)
C      METRIC          DEPTH UNITS IN METERS?
C      MODE            DEPTH UNITS OF MODEL PARAMETER SUB-FILE
C      NTISS           NUMBER OF HALFTIME TISSUES (9 MAX.)
C      P               TISSUE GAS TENSION ARRAY (FSW)
C      PACO2           ARTERIAL CO2 PARTIAL PRESSURE (FSW)
C      PAMB            AMBIENT PRESSURE (FSW)
C      PAO2            ARTERIAL O2 TENSION (FSW)
C      PBOVP           GAS PHASE OVERPRESSURE (FSW)
C      PH2O            PARTIAL PRESSURE OF WATER VAPOR (FSW)
C      PO2             INSPIRED OXYGEN PARTIAL PRESSURE (ATA)
C      PVCO2           VENOUS CO2 PARTIAL PRESSURE (FSW)
C      PVO2            VENOUS O2 PARTIAL PRESSURE (FSW)
C      RATE            RATE OF TRAVEL DURING DEPTH CHANGE (FSW OR MSW MIN)
C      SDR             SATURATION-DESATURATION HALFTIME RATIO
C      TC              TIME CHANGE DURING ASCENT (MIN)
C      UNITS           DEPTH UNITS OF MODEL PARAMETER SUB-FILE
C
C
C      NOTE: ALL PARTIAL PRESSURES WHICH ARE IN FSW. 33 FSW = 1 ATA.
C
C
C***********************************************************************
C
C***********************************************************************
C                              **********************
C                              * SUBROUTINES REQUIRED *
C                              **********************
C
C
C                   * HEWLETT PACKARD RTE IV-B OPERATING SYSTEM SUBROUTINES
C                     AND FUNCTIONS
C
C                   *CLOSE   CLOSES SPECIFIED DISK FILE
C                   *CODE    ALLOWS FOLLOWING READ TO OCCUR FROM MEMORY BUFFER
C                    FMPER   DECODES AND PRINTS RTE IV-B ERROR CODES ON ERROR
C                   *OPEN    OPENS SPECIFIED DISK FILE
C                   *READF   READS DATA FROM DISK FILE INTO MEMORY BUFFER
C
C***********************************************************************
C
C                          MODEL INPUT VARIABLES
C      THESE VARIABLES ARE SENT BETWEEN MODEL SUBROURINES ONLY.
C      THESE COMMON STATEMENTS MUST APPEAR IN ALL MODEL SUBROUTINES.
C
       COMMON/MDATA/ TC,DC,CDEPTH,RATE,CPO2,FN2,PO2,DINC,CF
       COMMON/PARAM/M(9,30),P(9),HLFTM(9),NTISS,SDR(9),IAD
       COMMON/BLDVL/PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
C
C
       LOGICAL CPO2,METRIC
       REAL M,IGAS(3),UNITS(2)
       INTEGER IDCB(144),IFILE(3),IBUF(36)
C
C
       DATA IL/36/,UNITS/4H FSW,4H MSW/
C
C
 10    FORMAT(9F7.2,I9)
 11    FORMAT(9F8.3)
```

```
12    FORMAT(2I8,3A4)
13    FORMAT(6/,33X"TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS"/
     *33X          "----------------------------------------"/
     *45X                    "("3A2"- "3A4")"2/
     *46X                 "TISSUE HALF-TIMES"2/
     *5X"  DEPTH "9(I6" MIN"))
14    FORMAT(13X,9(F6.2" SDR"))
15    FORMAT(
     *5X" -------   -------   -------   -------   -------   -------"
     *3X"-------   -------   -------   -------")
16    FORMAT(I9,A4,9F10.3)
17    FORMAT(2/,43X,"BLOOD PARAMETERS",//,35X"(PRESSURE IN FSW; 33 FSW=1
     * ATA)"/)
18    FORMAT(7X"PACO2"12X" PH2O"12X"PVCO2"12X" PVO2"12X"AMBAO2"
     *11X"PBOVP"/)
19    FORMAT(7X,F5.2,4F17.2,F17.3)
20    FORMAT("1")
C
C*************************************************************************
C
C                        FILE READ IN PROCEDURE
C
C*************************************************************************
C
C     IF "METRIC" IS TRUE THE DEPTH INCREMENTS ARE WANTED IN METERS.
C     INTEGERIZE STOP DEPTH INCREMENT DESIRED BY THE CALLING PROGRAM.
C
      IMODE=1
      IF(METRIC)IMODE=2
      IDINC=DINC
C
C     OPEN FILE "IFILE" INTO INPUT BUFFER "IDCB". ALL SUBSEQUENT READS
C     FROM "IFILE" WILL BE SPECIFIED TO BE FROM "IDCB". IF ERROR OCCURS
C     PRINT ERROR MESSAGE THEN STOP.
C
      CALL OPEN(IDCB,IERR,IFILE,3)
      CALL FMPER(IERR,IFILE,LU)
      IF (IERR.LT.0) STOP
C
C     READ IN 30 ROWS OF MAXIMUM TISSUE TENSIONS FOR 9 TISSUES FROM A
C     A SUB-FILE INTO MEMORY BUFFER "IBUF". THEN READ VALUES FROM "IBUF"
C     INTO ARRAY "M".
C
175   DO 180 J=1,30
      CALL READF (IDCB,IERR,IBUF,IL,LEN)
      CALL CODE
      READ (IBUF,11)(M(I,J),I=1,9)
180   CONTINUE
C
C     READ IN DEPTH UNITS "MODE", STOP DEPTH INCREMENT AND INERT GAS
C     LABEL OF SUB-FILE.
C
      CALL READF(IDCB,IERR,IBUF,IL,LEN)
      CALL CODE
      READ (IBUF,12) MODE,INCR,IGAS
C
C     READ IN TISSUE HALFTIMES AND NUMBER OF TISSUES FROM SUB-FILE.
C
      CALL READF(IDCB,IERR,IBUF,IL,LEN)
      CALL CODE
```

```
      READ (IBUF,10) HLFTM,NTISS
C
C     READ IN SATURATION-DESATURATION RATIOS FROM SUBFILE.
C
      CALL READF(IDCB,IERR,IBUF,IL,LEN)
      CALL CODE
      READ (IBUF,10) SDR
C
C     IF THE SUB-FILE JUST READ IN DOES NOT HAVE ITS PARAMETERS IN THE
C     DESIRED DEPTH UNITS OR STOP DEPTH INCREMENTS READ IN THE NEXT
C     SUB-FILE.
C
      IF(MODE.NE.IMODE ) GO TO 175
      IF(IDINC.NE.INCR) GO TO 175
C
C     CLOSE FILE "IFILE". IF ERROR OCCURS PRINT ERROR MESSAGE AND STOP.
C
      CALL CLOSE(IDCB,IERR)
      CALL FMPER(IERR,IFILE,LU)
      IF(IERR.LT.0) STOP
C
C     IF NO PRINTOUT DESIRED THEN RETURN.
C
      IF(IPRT.NE.1) RETURN
C
C*****************************************************************
C
C                    END FILE READ IN
C
C*****************************************************************
C
C*****************************************************************
C
C                    MODEL PARAMETER PRINTOUT PROCEDURE
C
C*****************************************************************
C
C     PRINT HEADER
C
      WRITE(LP,13) IFILE,IGAS,(HLFTM(I),I=1,NTISS)
      WRITE(LP,14)(SDR(I),I=1,NTISS)
      WRITE(LP,15)
C
C     PRINTOUT TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS.
C
      DO 200 J=1,30
      IDPTH=INCR*J
      WRITE(LP,16) IDPTH,UNITS(MODE),(M(I,J),I=1,NTISS)
200   CONTINUE
C
C     PRINT FOOTER
C
      WRITE(LP,15)
      WRITE(LP,17)
      WRITE(LP,18)
C
C     PRINTOUT VALUES IN COMMON BLOCK "BLDVL" THEN RETURN.
C
      WRITE(LP,19)PACO2,PH2O,PVCO2,PVO2,AMBAO2,PBOVP
      WRITE(LP,20)
```

```
      RETURN
C
C***********************************************************************
C
C                    END MODEL PARAMETER PRINTOUT
C
C***********************************************************************
C
      END
      END$
```

ANNEX C

PROGRAMS FOR COMPUTING ASCENT CRITERIA

ANNEX C-1

PROGRAM MVALU LISTING

```
&MVALU T=00004 IS ON CR00013 USING 00077 BLKS R=0000

FTN4
      PROGRAM MVALU(3,1000), 10 DEC 82 VER 1.1
C
C
C     CREATES MODEL PARAMETER INPUT FILE. EACH FILE WILL CONTAIN THREE
C     SUBFILES, THE FIRST WILL HAVE 10 FSW INCREMENTS, THE SECOND WILL
C     HAVE 3 MSW INCREMENTS AND THE THIRD 5 MSW INCREMENTS.
C
C     THE ACTUAL COMPUTATION OF THE MAXIMUM TISSUE TENSIONS IS DONE IN
C     SUBROUTINE "MCOMP".
C                     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                     @                                  @
C                     @            WRITTEN BY            @
C                     @                                  @
C                     @  CDR EDWARD D. THALMANN (MC) USN @
C                     @                                  @
C                     @                                  @
C                     @   U.S. NAVY EXPERIMENTAL DIVING  @
C                     @               UNIT               @
C                     @   PANAMA CITY,FLORIDA      32407 @
C                     @                                  @
C                     @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C*********************************************************************
C                                  *************
C                                  * VARIABLES *
C                                  *************
C
C            *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C               OPERATING SYSTEM.
C
C     ATMD           CONVERTS DEPTH UNITS TO FSW
C     FACTR          ARRAY HOLDING POSSIBLE VALUES OF "ATMD"
C     HLFTM          TISSUE HALFTIME ARRAY
C    *IBUF           MEMORY BUFFER FOR DISK FILES
C     ICONT          HOLDS TERMINAL RESPONSES TO QUESTIONS
C    *IDCB           DATA CONTROL BLOCK USUALLY FOR OUTPUT FILES
C    *IDCBM          DATA CONTROL BLOCK USUALLY FOR INPUT FILES
C     IDPTH          DEPTH FOR ROW OF "MTABLE" TISSUE TENSIONS
C    *IERR           RTE IV-B ERROR CODE(- IF ERROR)
C     IFILE          ARRAY CONTAINING OUTPUT FILENAME
C     IGAS           CURRENT INERT GAS NAME
C    *IL             SPECIFIED NUMBER OF CHARACTERS TO BE READ FOR FILE
C     INCR           STOP DEPTH INCREMENT READ FROM FILE
C     IOPT           NUMBER OF THE OPTION SELECTED
C    *IPAR           LOGICAL UNIT NUMBER ARRAY
C    *ISES           DUMMY VARIABLE
C     JGAS           NEW INERT GAS NAME
C     LP             DEVICE NUMBER OF LINE PRINTER
C     LU             DEVICE NUMBER OF TERMINAL
C     MFILE          ARRAY CONTAINING INPUT FILENAME
C     MODE           DEPTH UNITS(1-FEET, 2-METERS)
C     MTABLE         MODEL PARAMETER INPUT FILE OUTPUT ARRAY
C     MULTP          DEPTH MULTIPLIER
C     NAM            ARRAY HOLDING PROGRAM NAME
C     NTISS          NUMBER OF TISSUES
C     SDR            SATURATION-DESATURATION RATIOS
```

```
C     STNSH           MAXIMUM TISSUE TENSIONS FOR SURFACING
C     UNITS
C
C**************************************************************************
C
C**************************************************************************
C
C                          ************************
C                          * SUBROUTINES REQUIRED *
C                          ************************
C
C            * HEWLETT PACKARD RTE IV-B OPERATING SYSTEM SUBROUTINES
C              AND FUNCTIONS
C
C             *CLOSE    CLOSES DISK FILE
C             *CODE     ALLOWS NEXT READ TO OCCUR FROM MEMORY BUFFER
C             *CREAT    CREATES NEW FILE
C              FMPER    DECODES AND PRINTS RTE IV-B ERROR MESSAGES
C             *LOGLU    LOGICAL UNIT # OF TERMINAL
C             *LUTRU    LOGICAL UNIT NUMBER OF TERMINAL ON ERROR
C              MCOMP    COMPUTES ONE SET OF MAXIMUM TISSUE TENSIONS
C             *POSTN    POSITIONS DISK FILE TO SPECIFIED RECORD
C             *PURGE    ELIMINATES SPECIFIED FILE FROM DISK
C             *READF    READS DATA FROM DISK FILE INTO MEMORY BUFFER
C             *RMPAR    PASSES LOGICAL UNIT # OF TERMINAL TO PROGRAM
C             *RWNDF    POSTIONS FILE TO FIRST RECORD
C             *WRITF    WRITE FROM MEMORY BUFFER TO DISK FILE
C
C**************************************************************************
C
      INTEGER IPAR(5),NAM(3),IFILE(3),MFILE(3),IDCB(144),IBUF(36),
     *        IDCBM(144)
      REAL    UNITS(2),STNSH(9),FACTR(2),IGAS(3),JGAS(3),HLFTM(9),
     *        SDR(9),MTABLE(3,9,30),MULTP
      DATA UNITS/4H FSW, 4H MSW/, FACTR/ 1., 3.28084/, IL/36/,
     *    IGAS/3*4H    /,  NAM /2HMV,2HAL,2HU /, SDR,NTISS/9*1.0,9/,
     *    HLFTM/5.,10.,20.,40.,80.,120.,160.,200.,240./
C
      DATA STNSH/9*0.0/, MULTP/1.0/
C
C
1     FORMAT(3A2)
2     FORMAT("SELECT OPTION: 1-LIST ONLY  2-CREATE NEW MATRIX  6-EXIT")
3     FORMAT("SELECT CREATE OPTION"/
     *25X"3-CREATE NEW FILE"/
     *25X"4-MODIFY OLD FILE"/
     *25X"5-CREATE NEW FILE USING OLD FILE AS INPUT"/
     *25X"6-EXIT PROGRAM")
4     FORMAT("PRINTOUT MAXIMUM TISSUE TENSION TABLES? (YES/NO)")
6     FORMAT(" CURRENT MULTIPLIER, ENTER CHANGE"/F9.2)
7     FORMAT("ENTER FILE NAME FOR NEW VALUE MATRIX")
8     FORMAT("INERT GAS IS "3A4" ENTER CHANGE")
9     FORMAT(3A4)
10    FORMAT(9F7.2,I9)
11    FORMAT("NTISS ="I6)
12    FORMAT("CURRENT HALFTIMES,ENTER CHANGES"/9F8.2)
13    FORMAT("CURRENT SDR'S, ENTER CHANGES"/9F8.2)
14    FORMAT(
     *" CURRENT NUMBER OF COMPARTMENTS ACTIVE IS "I2".  ENTER CHANGE")
15    FORMAT(" CURRENT SURFACING TENSIONS, ENTER CHANGES"/9F8.3)
```

```
16    FORMAT( )
17    FORMAT("ENTER FILE NAME OF EXISTING MATRIX FILE")
18    FORMAT(9F8.3)
19    FORMAT(3(9F7.2,/),I4)
20    FORMAT(2I8,3A4)
21    FORMAT("CONTINUE? (YES OR NO) _")
22    FORMAT("DONE CHANGING? GO ON TO COMPUTATION? (YES OR NO) -")
23    FORMAT(6/
     *51X                 "TABLE"I2/
     *51X                 "-------"4/
     *33X        "TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS"/
     *33X        "--------------------------------------------"/
     *45X                      "("3A2"- "3A4")"2/)
24    FORMAT(46X           "TISSUE HALF-TIMES"2/
     *5X"  DEPTH "9(I6" MIN"))
25    FORMAT(13X,9(F6.2" SDR"))
26    FORMAT(
     *5X" -------   -------   -------   -------   -------   -------"
     *3X"-------   -------   -------   -------")
27    FORMAT(I9,A4,9F10.3)
28    FORMAT("1")
C
C**************************************************************************
C
C                INITIALIZATION AND OPTION SELECT PROCEDURE
C
C**************************************************************************
C
C     GET LOGICAL UNIT NUMBERS OF TERMINAL(LU) AND LINE PRINTER(LP).
C
      CALL RMPAR(IPAR)
      LU=IPAR(1)
      IF(LU.LE.1) LU=LUTRU( LU )
      IF(LU.LE.0) LU=LOGLU(ISES)
      LP=6
C
C     GET DESIRED OPTION FROM TERMINAL(1-PRINT 2-CREATE 6-EXIT PROGRAM)
C     IF 1,2 OR 6 NOT SPECIFIED ASK FOR DESIRED OPTION AGAIN.
C
40    WRITE(LU,2)
      IOPT=6
      READ(LU,*) IOPT
      IF(IOPT.EQ.1) GO TO 50
      IF(IOPT.EQ.6) STOP
      IF(IOPT.NE.2) GO TO 40
C
C     SELECT CREATE OPTION.(3-MAKE NEW FILE, 4-MODIFY EXISTING FILE
C     5-MAKE A NEW FILE STARTING WITH AN EXISTING FILE, 6-EXIT PROGRAM)
C     IF A 3,4,5,OR 6 NOT SPECIFIED ASK FOR DESIRED OPTION AGAIN.
C
45    WRITE(LU,3)
      IOPT=6
      READ(LU,*) IOPT
      IF(IOPT.EQ.6) STOP
      IF(IOPT.EQ.3) GO TO 55
      IF(IOPT.EQ.5) GO TO 50
      IF(IOPT.NE.4) GO TO 45
C
C**************************************************************************
C
```

```
C                     END INITIALIZATION AND OPTION SELECT
C
C*****************************************************************************
C
C*****************************************************************************
C
C                     FILE SPECIFICATION AND READ IN PROCEDURE
C
C      OPENS NEEDED INPUT FILES, CREATES NEEDED OUTPUT FILES, AND READS I
C      NEEDED STARTING VALUES FROM THE INPUT FILE.
C
C*****************************************************************************
C
C      GET INPUT FILE NAME FOR OPTIONS 1, 4, OR 5. IF NO FILENAME
C      GO BACK AND ASK FOR DESIRED OPTIONS AGAIN.
C
50     WRITE(LU,17)
       READ(LU,1) MFILE
       IF(MFILE.NE.2H  ) GO TO 53
       IF(IOPT.EQ.1) GO TO 40
       GO TO 45
C
C      IF OPTION 1 SELECTED GO TO PRINTOUT PROCEDURE.
C
53     IF(IOPT.EQ.1) GO TO 170
C
C      IF OPTION 4 SELECTED NO NEW OUTPUT FILE NEEDED. GO OPEN INPUT FILE
C
       IF(IOPT.EQ.4) GO TO 58
C
C      GET NAME OF NEW OUTPUT FILE IF OPTION 3 OR 5 SELECTED.
C      IF NO FILENAME SPECIFIED GO BACK AND ASK FOR DESIRED OPTION AGAIN.
C
55     WRITE(LU,7)
       READ(LU,1) IFILE
       IF(IFILE.EQ.2H  ) GO TO 45
C
C      CREATE NEW OUTPUT FILE. IF AN ERROR OCCURS(IERR.LT.0) GO BACK AND
C      ASK FOR ANOTHER OUTPUT FILENAME.
C
       CALL CREAT(IDCB,IERR,IFILE,29,4,0,60)
       CALL FMPER(IERR,NAM,LU)
       IF(IERR.LT.0) GO TO 55
C
C      IF OPTION 3 SELECTED NO FILE INPUT NEEDED. VALUES OF ALL VARIABLES
C      WILL REMAIN AS THEY WERE SET IN DATA STATEMENT.
C
       IF(IOPT.EQ.3) GO TO 65
C
C      OPEN INPUT FILE IF OPTION 4 OR 5 SELECTED. GO BACK FOR NEW
C      ON ERROR.
C
58     CALL OPEN(IDCBM,IERR,MFILE,3)
       CALL FMPER(IERR,NAM,LU)
       IF(IERR.LT.0) GO TO 50
C
C      READ FIRST RECORD OF INPUT FILE INTO SURFACING TENSION ARRAY
C      "STNSN".
C
       CALL READF(IDCBM,IERR,IBUF,IL)
```

```
      CALL FMPER(IERR,NAM,LU)
      CALL CODE
      READ(IBUF,18) STNSN
C
C     POSITION FILE TO 31ST RECORD AND READ IT INTO UNITS MODE "MODE",
C     STOP DEPTH INCREMENT "INCR" AND INERT GAS LABEL ARRAY "IGAS".
C
      CALL POSNT(IDCBM,IERR,29,0)
      CALL READF(IDCBM,IERR,IBUF,IL)
      CALL FMPER(IERR,NAM,LU)
      CALL CODE
      READ(IBUF,20) MODE,INCR,IGAS
C
C     READ IN TISSUE HALFTIMES INTO ARRAY "HLFTM" AND THE NUMBER OF
C     TISSUES INT "NTISS" FROM THE 32ND RECORD.
C
      CALL READF(IDCBM,IERR,IBUF,IL)
      CALL FMPER(IERR,NAM,LU)
      CALL CODE
      READ(IBUF,10) HLFTM,NTISS
C
C     READ IN SATURATION-DESATURATION RATIOS INTO ARRAY "SDR" FROM 33RD
C     RECORD.
C
      CALL READF(IDCBM,IERR,IBUF,IL)
      CALL FMPER(IERR,NAM,LU)
      CALL CODE
      READ(IBUF,10) SDR
C
C     CLOSE INPUT FILE JUST IN CASE
C
      CALL CLOSE(IDCBM)
C
C     WRITE OUT STARTING STNSN,HLFTM,SDR,AND NTISS VALUES TO TERMINAL.
C
65    WRITE(LU,19) STNSN,HLFTM,SDR,NTISS
      WRITE(LU,21)
C
C     WANT TO CONTINUE? IF NOT GO BACK TO SELECT DESIRED OPTION AGAIN.
C
      READ(LU,1) ICONT
      IF(ICONT.NE.2HYE) GO TO 45
C
C*****************************************************************
C
C                     END FILE SPECIFICATION AND READ IN
C
C*****************************************************************
C
C*****************************************************************
C
C                     STARTING VARIABLE CHANGE PROCEDURE
C
C     ALLOWS DESIRED VALUES TO BE CHANGED. HITTING A RETURN KEY RETAINS
C     DISPLAYED VALUES.
C
C*****************************************************************
C
C     CHANGE INERT GAS NAME.
C
```

```
70    WRITE(LU,8) IGAS
      READ(LU,9) JGAS
      IF(JGAS.EQ.4H    ) GO TO 75
      DO 72 I=1,3
72    IGAS(I)=JGAS(I)
C
C     CHANGE NUMBER OF TISSUES.
C
75    WRITE(LU,14) NTISS
      READ(LU,*) NTISS
C
C     CHANGE SURFACING TISSUE TENSIONS.
C
      WRITE(LU,15) (STNSN(I),I=1,NTISS)
      READ(LU,*) STNSN
C
C     CHANGE TISSUE HALFTIMES.
C
      WRITE(LU,12) (HLFTM(I),I=1,NTISS)
      READ(LU,*) HLFTM
C
C     CHANGE SATURATION DESATURATION RATIOS.
C
      WRITE(LU,13) (SDR (I),I=1,NTISS)
      READ(LU,*) SDR
C
C     CHANGE DEPTH MULTIPLIER.
C
      WRITE(LU,6) MULTP
      READ(LU,*) MULTP
C
C     IF DONE CHANGING GO COMPUTE TABLE OF MAXIMUM TISSUE TENSIONS. IF
C     MORE CHANGES DESIRED OR TO REVIEW VALUES GO BACK TO BEGINNING OF
C     PROCEDURE.
C
      WRITE(LU,22)
      READ(LU,1) ICONT
      IF(ICONT.NE.2HYE) GO TO 70
C
C**********************************************************************
C
C                       END CHANGE PROCEDURE
C
C**********************************************************************
C
C**********************************************************************
C
C           MAXIMUM PERMISSIBLE TISSUE TENSION COMPUTATION PROCEDURE
C
C**********************************************************************
C
C     GET SURFACING TENSIONS INTO FIRST ROW OF "MTABLE".
C
      DO 80 K=1,3
        DO 80 I=1,NTISS
80        MTABLE(K,I,1)=STNSN(I)
C
C
C     COMPUTE THREE SETS OF MAXIMUM TISSUE TENSIONS IN 10 FSW,3 AND 5
C     MSW INCREMENTS.
```

```
C
      DO 120 K=1,3
        MODE=1
        IF(K.GT.1) MODE=2
C
C     SELECT APPROPRIATE CONVERSION FACTOR TO CONVERT VALUE OF "INCR" TO
C     UNITS OF FSW. ALL MAXIMUM TISSUE TENSIONS IN UNITS OF FSW BUT THE
C     DEPTH INCREMENT MAY BE IN FEET OR METERS.
C
        ATMD=FACTR(MODE)
        INCR=10
        IF(K.EQ.2) INCR=3
        IF(K.EQ.3) INCR=5
C
C     COMPUTE ONE SET OF MAXIMUM TISSUE TENSIONS FOR 30 DEPTH INCREMENTS
C
      CALL MCOMP(MTABLE,K,MULTP,INCR,ATMD)
120   CONTINUE
C
C*********************************************************************
C
C                 END MAXIMUM TISSUE TENSION COMPUTATION
C
C*********************************************************************
C
C*********************************************************************
C
C                        FILE OUTPUT PROCEDURE
C
C*********************************************************************
C
C     GET RID OF OLD FILE AND CREATE NEW FILE WITH SAME NAME FOR
C     OPTION 4 ONLY.
C
      IF(IOPT.NE.4) GO TO 140
      CALL PURGE(IDCBM,IERR,MFILE)
      CALL FMPER(IERR,MFILE,LU)
      CALL CREAT(IDCB,IERR,MFILE,29,4,0,60)
      CALL FMPER(IERR,MFILE,LU)
      DO 130 I=1,3
130   IFILE(I)=MFILE(I)
C
C     OPEN OUTPUT FILE, GO BACK AND ASK FOR DESIRED OPTION ON ERROR.
C
140   CALL OPEN(IDCB,IERR,IFILE,3)
      CALL FMPER(IERR,IFILE,LU)
      IF(IERR.LT.0) GO TO 45
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     WRITE THREE SUB-FILES TO THE OUTPUT FILE.
C
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
      DO 160 K=1,3
C
C     SET DEPTH UNITS MODE AND INCREMENT
C
        MODE=1
        IF(K.GT.1) MODE=2
```

```
       INCR=10
       IF(K.EQ.2) INCR=3
       IF(K.EQ.3) INCR=5
C
C     WRITE MTABLE TO OUTPUT FILE
C
       DO 150 J=1,30
         WRITE(LU,18) (MTABLE(K,I,J),I=1,NTISS)
         CALL CODE
         WRITE(IBUF,18) (MTABLE(K,I,J),I=1,9)
         CALL WRITF(IDCB,IERR,IBUF,IL)
150      CONTINUE
C
C     WRITE OUT UNITS,DEPTH INCREMENT, AND INERT GAS NAME.
C
       WRITE(LU,20) MODE,INCR,IGAS
       CALL CODE
       WRITE(IBUF,20) MODE,INCR,IGAS
       CALL WRITF(IDCB,IERR,IBUF,14)
C
C     WRITE OUT HALFTIMES AND NTISS
C
       WRITE(LU,11) NTISS
       WRITE(LU,10) (HLFTM(I),I=1,NTISS)
       CALL CODE
       WRITE(IBUF,10) HLFTM,NTISS
       CALL WRITF(IDCB,IERR,IBUF,IL)
C
C     WRITE OUT SDR VALUES
C
       WRITE(LU,10) (SDR(I),I=1,NTISS)
       WRITE(LU,16)
       CALL CODE
       WRITE(IBUF,10) SDR,NTISS
       CALL WRITF(IDCB,IERR,IBUF,IL)
160    CONTINUE
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                      DONE WRITING 3 SUB-FILES
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     ASK IF PRINTOUT WANTED. IF "NO" CLOSE FILE AND GO BACK TO SELECT
C     DESIRED OPTION. IF "YES" REWIND FILE BEFORE GOING TO PRINTOUT
C     PROCEDURE.
C
      WRITE(LU,4)
      READ(LU,1) ICONT
      IF(ICONT.NE.2HYE) GO TO 165
      CALL RWNDF(IDCB,IERR)
      GO TO 175
165   CALL CLOSE(IDCB,IERR)
      CALL FMPER(IERR,NAM,LU)
      GO TO 40
C
C****************************************************************************
C
C                       PRINTOUT PROCEDURE
C
```

```
C**********************************************************************
C
C     OPTION 1 ENTERS HERE BECAUSE INPUT FILE MUST BE OPENED FIRST.
C     GO BACK TO GET ANOTHER FILENAME ON ERROR. "IFILE" AND "MFILE"
C     ARE THE SAME FILE FOR OPTION 1.
C
170   CALL OPEN(IDCB,IERR,MFILE,3)
      CALL FMPER(IERR,NAM,LU)
      IF(IERR.LT.0) GO TO 50
      DO 172 I=1,3
172    IFILE(I)=MFILE(I)
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     PRINT OUT THREE TABLES FROM THE THREE SUBFILES.
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
175   DO 210 K=1,3
        DO 180 J=1,30
          CALL READF(IDCB,IERR,IBUF,IL,LEN)
          CALL CODE
          READ(IBUF,18) (MTABLE(K,I,J),I=1,9)
180       CONTINUE
C
C     READ IN DEPTH UNITS MODE,INCR,GAS
C
        CALL READF(IDCB,IERR,IBUF,IL)
        CALL CODE
        READ(IBUF,20) MODE,INCR,IGAS
        CALL READF(IDCB,IERR,IBUF,IL)
        CALL CODE
        READ(IBUF,10) HLFTM,NTISS
        CALL READF(IDCB,IERR,IBUF,IL)
        CALL CODE
        READ(IBUF,10) SDR
C
C     PRINT HEADER
C
        WRITE(LP,23) K,IFILE,IGAS
        WRITE(LP,24) (HLFTM(I),I=1,NTISS)
        WRITE(LP,25) (SDR(I),I=1,NTISS)
        WRITE(LP,26)
        DO 200 J=1,30
          IDPTH=INCR*J
          WRITE(LP,27) IDPTH,UNITS(MODE),(MTABLE(K,I,J),I=1,NTISS)
200       CONTINUE
C
C     PRINT FOOTER
C
        WRITE(LP,26)
        WRITE(LP,28)
210     CONTINUE
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                     DONE PRINTING SUB-FILES
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
```

```
C      CLOSE FILE AND GO BACK TO SELECT NEW OPTION.
C
       CALL CLOSE(IDCB,IERR)
       CALL FMPER(IERR,NAM,LU)
       GO TO 40
C
C**********************************************************************
C
C                      END PRINTOUT PROCEDURE
C
C**********************************************************************
C
       END
       END$
```

ANNEX C-2

SUBROUTINE MCOMP
(Version 1.0)
LISTING

```
&MCOMP T=00004 IS ON CR00014 USING 00077 BLKS R=0000

FTN4
      SUBROUTINE MCOMP(MTABLE,K,MULTP,INCR,ATMD), 10 DEC 82 VER 1.0
C
C
C     COMPUTES A TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS FROM THE
C     VALUES IN THE FIRST ROW OF "MTABLE" (THE SURFACING TENSIONS).
C     THE TENSIONS AT DEPTH ARE RELATED TO THE SURFACING TENSIONS
C     BY THE RELATIONSHIP:
C
C              TENSION AT DEPTH = SURFACING TENSION + DEPTH*MULTP
C
C     THE SURFACING TENSIONS AND THE DEPTH MULTIPLIER (MULTP) MUST BE
C     SPECIFIED.
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                 @                                    @
C                 @              WRITTEN BY            @
C                 @                                    @
C                 @  CDR EDWARD D. THALMANN (MC) USN   @
C                 @                                    @
C                 @                                    @
C                 @   U.S. NAVY EXPERIMENTAL DIVING    @
C                 @              UNIT                  @
C                 @   PANAMA CITY,FLORIDA     32407    @
C                 @                                    @
C                 @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C***********************************************************************
C                                ***********
C                                * VARIABLES *
C                                ***********
C
C          *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C             OPERATING SYSTEM.
C
C    ATMD           CONVERTS DEPTH UNITS TO FSW
C    INCR           STOP DEPTH INCREMENT READ FROM FILE
C    MTABLE         ARRAY HOLDING THREE SUB-FILE VALUES
C    MULTP          DEPTH MULTIPLIER
C
C***********************************************************************
C
C
      REAL MTABLE(3,9,30),MULTP
C
C
C     COMPUTE ONE SET OF MAXIMUM TENSIONS.
C
      DO 100 J=2,30
      DO 100 I=1,9
100   MTABLE(K,I,J)=MTABLE(K,I,J-1)+MULTP*INCR*ATMD
      RETURN
      END
      END$
```

ANNEX C-3

SUBROUTINE MCOMP
(Version 2.0)
LISTING

&MCMP2 T=00004 IS ON CR00015 USING 00026 BLKS R=0000

```
FTN4
      SUBROUTINE MCOMP(MTABLE,K,MULTP,INCR,ATMD), 10 DEC 82 VER 2.0
C
C
C     COMPUTES A TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS FROM THE
C     VALUES IN THE FIRST ROW OF "MTABLE" (THE SURFACING TENSIONS).
C     THE TENSIONS AT DEPTH ARE RELATED TO THE SURFACING TENSIONS BY THE
C     RELATIONSHIP:
C
C                    M = FN2 * 33 * ((SR/R)**10 + R - 1)
C
C     WHERE:
C
C               M   = MAXIMUM PREMISSIBLE TISSUE TENSION AT A GIVEN DEPTH
C               SR  = SURFACING TENSION / 33.*FN2  (THE SURFACING RATIO)
C               R   = M / (DEPTH + 33)*FN2      (THE DEPTH RATIO)
C               FN2= FRACTION OF NITROGEN
C
C     THE VALUES OF "SR" (SURFACING RATIOS) ARE EMPIRICALLY DERIVED. THE
C     ABOVE EQUATION CANNOT BE EXPLICITLY SOLVED FOR "M" AND MUST BE
C     SOLVED BY ITERATION.
C
C
C
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                   @                                   @
C                   @              WRITTEN BY           @
C                   @                                   @
C                   @  CDR EDWARD D. THALMANN (MC) USN  @
C                   @                                   @
C                   @                                   @
C                   @   U.S. NAVY EXPERIMENTAL DIVING   @
C                   @               UNIT                @
C                   @   PANAMA CITY,FLORIDA     32407   @
C                   @                                   @
C                   @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C
C
C*******************************************************************
C                                 *************
C                                 * VARIABLES *
C                                 *************
C
C         *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C            OPERATING SYSTEM.
C
C    ATMD           CONVERTS DEPTH UNITS TO FSW
C    DN2            CURRENT AMBIENT INERT GAS TENSION
C    DN2OLD         PREVIOUS AMBIENT INERT GAS TENSION
C    DY             FIRST DERIVITIVE OF "Y"
C    FN2            NITROGEN FRACTION
C    IPRNT          ALWAYS PRINT ITERATION VALUES IF = 1
C    M              MAXIMUM TENSION AT CURRENT DEPTH
C    MTABLE         ARRAY HOLDING THREE SUB-FILE VALUES
C    MULTP          DEPTH MULTIPLIER
C    NITR           NUMBER OF NEWTON RAPHSON ITERATIONS
```

```
C     R                 DEPTH RATIO
C     SCHK              VARIABLE USED TO CHECK FOR SIGN CHANGE
C     SR                SURFACING RATIO
C     T                 MAXIMUM TISSUE TENSION
C     T1                TRIAL VALUE OF "T"
C     TERROR            MAXIMUM ITERATION ERROR
C     VALIT             ARRAY CONTAINING ITERATION VALUES
C     Y                 NEWTON RAPHSON NULL VARIABLE
C     Y1                TRIAL VALUE OF "Y"
C
C**********************************************************************
C
C
      REAL MTABLE(3,9,30),MULTP,M,VALIT(4,10)
C
C
1     FORMAT(//10X"NEWTON RAPHSON ITERATION"//
     *6X"I"6X"J"6X"K"6X"M"
     */3X,I4,3X,I4,3X,I4,F13.6,1X//
     *9X"T"17X"Y"14X"DY"13X" Y/DY"/10(4F16.7/)////)
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C                             BEGIN
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C     SET "IPRNT" TO "1" IF ITERATION PRINTOUT ALWAYS WANTED. OTHERWISE
C     SET TO "0".
C
      IPRNT=0
C
C     SET INERT GAS FRACTION TO 79%.
C
      FN2=0.79
C
C
C     COMPUTE ONE SET OF MAXIMUM TENSIONS.
C
      DO 400 I=1,9
      DO 400 J=2,30
C
C       CC..PUTE DEPTH FOR THIS AND PREVIOUS ROW OF "MTABLE".
C
      DN2=((J-1)*INCR*ATMD+33.)*FN2
      DN2OLD=((J-2)*INCR*ATMD+33.)*FN2
C
C     COMPUTE SURFACING RATIO
C
      SR=MTABLE(K,I,1)/(33.*FN2)
C
C**********************************************************************
C
C                   NEWTON RAPHSON ITERATION
C
C**********************************************************************
C
C     INITIALIZE NUMBER OF ITERATIONS TO "0".
C
      NITR=0
```

```
C
C     COMPUTE DEPTH RATIO "R". "Y" WILL BE EXACTLY 0.0 WHEN "T" IS
C     THE CORRECT MAXIMUM TENSION FOR THIS DEPTH. "DY" IS THE FIRST
C     DERIVITIVE OF "Y".
C
      T=MTABLE(K,I,J-1)*(DN2)/(DN2OLD)
  230 R=T/(DN2)
      Y=T-33.*FN2*((SR/R)**10+R-1)
      DY=1+(330.*FN2/T)*(SR/R)**10-(33.*FN2/DN2)
C
C     SEED ERROR CHECK WITH "T" AND "Y" ON FIRST PASS.
C
      IF(NITR.GT.0) GO TO 240
      T1=T
      Y1=Y
  240 NITR=NITR+1
C
C     SAVE ITERATION VALUES FOR IN CASE PRINTOUT OCCURS.
C
      VALIT(1,NITR)=T
      VALIT(2,NITR)=Y
      VALIT(3,NITR)=DY
      VALIT(4,NITR)=Y/DY
C
C     STOP ITERATION IF "Y" AND "Y/DY" ARE BOTH LESS THAN THE ACCEPTABLE
C     ERROR.
C
      IF(ABS(Y/DY).LE.0.0001 .AND. ABS(Y).LT.0.001) GO TO 270
C
C     STOP ITERATION AFTER 10 PASSES NO MATTER WHAT.
C
      IF(NITR.EQ.10) GO TO 270
C
C     IF "Y" HAS UNDERGONE A SIGN CHANGE SINCE LAST RECORDING "T1" THEN
C     "ABS(T-T1)" IS THE MAXIMUM ERROR FOR "T". IF THIS ERROR IS
C     ACCEPTABLE THEN STOP ITERATION. THIS TERMINATES ITERATIONS WHERE
C     "Y" OSCILLATES AROUND ZERO MORE RAPIDLY. IF "SCHK" IS POSITIVE
C     THEN NO SIGN CHANGE OCCURED AND NO ERROR CHECK MADE.
C
      SCHK=SIGN(1.0,Y)*SIGN(1.0,Y1)
      IF(SCHK.GT.0) GO TO 260
      TERROR=ABS(T1-T)
      IF(TERROR.LT.0.0001) GO TO 270
      T1=T
      Y1=Y
C
C     COMPUTE NEW ESTIMATE OF THE CROSSOVER TIME FOR THE NEXT PASS.
C
  260 T=T-(Y/DY)
      GO TO 230
C
C     WRITE OUT ITERATION VALUES IF CONVERGENCE TO ERROR LIMITS HAS NOT
C     OCCURED IN 10 ITERATIONS OR IF PRINT MODE ON (IPRNT=1).
C
  270 IF(NITR.LT.10 .AND. IPRNT.EQ.0) GO TO 300
      WRITE(6,1) I,J,K,MTABLE(K,I,J-1),((VALIT(N,L),N=1,4),L=1,NITR)
  300 MTABLE(K,I,J)=T
C
C***********************************************************************
C
```

```
C                       END NEWTON RAPHSON ITERATION
C
C************************************************************************
C
400    CONTINUE
       RETURN
       END
       END$
```

ANNEX C-4

SUBROUTINE MCOMP
(Version 2.1)
LISTING

&MCMP3 T=00004 IS ON CR00015 USING 00010 BLKS R=0000

```
FTN4
         SUBROUTINE MCOMP(MTABLE,K,MULTP,INCR,ATMD), 10 DEC 82 VER 2.1
C
C
C        COMPUTES A TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS FROM THE
C        RELATIONSHIP:
C
C        FOR DEPTHS GREATER THAN OR EQUAL TO 80 FSW:
C
C                 M = 67.46 + 1.157*D - (17.46 + 0.157*D)*(0.5**(D/50))
C
C        AND FOR DEPTHS LESS THAN 80 FSW:
C
C                     M = 29.59 + 1.035*(D + 33)
C
C        WHERE "D" IS DEPTH IN FSW AND "M" THE MAXIMUM PERMISSIBLE TISSUE
C        TENSION IN FSW.
C
C                    @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C                    @                                    @
C                    @             WRITTEN BY             @
C                    @                                    @
C                    @  CDR EDWARD D. THALMANN (MC) USN   @
C                    @                                    @
C                    @                                    @
C                    @   U.S. NAVY EXPERIMENTAL DIVING    @
C                    @              UNIT                  @
C                    @   PANAMA CITY,FLORIDA     32407    @
C                    @                                    @
C                    @@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C
C*************************************************************************
C                                ************
C                                * VARIABLES *
C                                ************
C
C            *  VARIABLES ASSOCIATED WITH HEWLETT PACKARD RTE IV-B
C               OPERATING SYSTEM.
C
C       ATMD            CONVERTS DEPTH UNITS TO FSW
C       D               DEPTH OF MAXIMUM TENSION (FSW)
C       INCR            STOP DEPTH INCREMENT READ FROM FILE
C       M               MAXIMUM TENSION AT CURRENT DEPTH
C       MTABLE          ARRAY HOLDING THREE SUB-FILE VALUES
C       MULTP           DEPTH MULTIPLIER
C
C*************************************************************************
C
C
         REAL MTABLE(3,9,30),MULTP,M
C
C
C        COMPUTE ONE SET OF MAXIMUM TENSIONS.
C
         DO 100 J=1,30
         D=(J-1)*INCR*ATMD
         IF(D.LE.80) M=67.46+D*1.157-(17.46+0.157*D)*(0.5**(D/50.))
```

```
      IF(D.GT.80) M=29.59+1.035*(D+33)
      DO 90 I=1,9
90    MTABLE(K,I,J)=M
100   CONTINUE
      RETURN
      END
      END$
```

ANNEX C-5

MCOMP VERSION 1.0
ASCENT CRITERIA

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL01- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	130.000	110.000	83.000	66.000	54.000	48.000	44.500	44.000	43.500
20 FSW	140.000	120.000	93.000	76.000	64.000	58.000	54.500	54.000	53.500
30 FSW	150.000	130.000	103.000	86.000	74.000	68.000	64.500	64.000	63.500
40 FSW	160.000	140.000	113.000	96.000	84.000	78.000	74.500	74.000	73.500
50 FSW	170.000	150.000	123.000	106.000	94.000	88.000	84.500	84.000	83.500
60 FSW	180.000	160.000	133.000	116.000	104.000	98.000	94.500	94.000	93.500
70 FSW	190.000	170.000	143.000	126.000	114.000	108.000	104.500	104.000	103.500
80 FSW	200.000	180.000	153.000	136.000	124.000	118.000	114.500	114.000	113.500
90 FSW	210.000	190.000	163.000	146.000	134.000	128.000	124.500	124.000	123.500
100 FSW	220.000	200.000	173.000	156.000	144.000	138.000	134.500	134.000	133.500
110 FSW	230.000	210.000	183.000	166.000	154.000	148.000	144.500	144.000	143.500
120 FSW	240.000	220.000	193.000	176.000	164.000	158.000	154.500	154.000	153.500
130 FSW	250.000	230.000	203.000	186.000	174.000	168.000	164.500	164.000	163.500
140 FSW	260.000	240.000	213.000	196.000	184.000	178.000	174.500	174.000	173.500
150 FSW	270.000	250.000	223.000	206.000	194.000	188.000	184.500	184.000	183.500
160 FSW	280.000	260.000	233.000	216.000	204.000	198.000	194.500	194.000	193.500
170 FSW	290.000	270.000	243.000	226.000	214.000	208.000	204.500	204.000	203.500
180 FSW	300.000	280.000	253.000	236.000	224.000	218.000	214.500	214.000	213.500
190 FSW	310.000	290.000	263.000	246.000	234.000	228.000	224.500	224.000	223.500
200 FSW	320.000	300.000	273.000	256.000	244.000	238.000	234.500	234.000	233.500
210 FSW	330.000	310.000	283.000	266.000	254.000	248.000	244.500	244.000	243.500
220 FSW	340.000	320.000	293.000	276.000	264.000	258.000	254.500	254.000	253.500
230 FSW	350.000	330.000	303.000	286.000	274.000	268.000	264.500	264.000	263.500
240 FSW	360.000	340.000	313.000	296.000	284.000	278.000	274.500	274.000	273.500
250 FSW	370.000	350.000	323.000	306.000	294.000	288.000	284.500	284.000	283.500
260 FSW	380.000	360.000	333.000	316.000	304.000	298.000	294.500	294.000	293.500
270 FSW	390.000	370.000	343.000	326.000	314.000	308.000	304.500	304.000	303.500
280 FSW	400.000	380.000	353.000	336.000	324.000	318.000	314.500	314.000	313.500
290 FSW	410.000	390.000	363.000	346.000	334.000	328.000	324.500	324.000	323.500
300 FSW	420.000	400.000	373.000	356.000	344.000	338.000	334.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL02- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	130.000	110.000	88.000	70.000	56.000	50.000	45.500	44.000	43.500
20 FSW	140.000	120.000	98.000	80.000	66.000	60.000	55.500	54.000	53.500
30 FSW	150.000	130.000	108.000	90.000	76.000	70.000	65.500	64.000	63.500
40 FSW	160.000	140.000	118.000	100.000	86.000	80.000	75.500	74.000	73.500
50 FSW	170.000	150.000	128.000	110.000	96.000	90.000	85.500	84.000	83.500
60 FSW	180.000	160.000	138.000	120.000	106.000	100.000	95.500	94.000	93.500
70 FSW	190.000	170.000	148.000	130.000	116.000	110.000	105.500	104.000	103.500
80 FSW	200.000	180.000	158.000	140.000	126.000	120.000	115.500	114.000	113.500
90 FSW	210.000	190.000	168.000	150.000	136.000	130.000	125.500	124.000	123.500
100 FSW	220.000	200.000	178.000	160.000	146.000	140.000	135.500	134.000	133.500
110 FSW	230.000	210.000	188.000	170.000	156.000	150.000	145.500	144.000	143.500
120 FSW	240.000	220.000	198.000	180.000	166.000	160.000	155.500	154.000	153.500
130 FSW	250.000	230.000	208.000	190.000	176.000	170.000	165.500	164.000	163.500
140 FSW	260.000	240.000	218.000	200.000	186.000	180.000	175.500	174.000	173.500
150 FSW	270.000	250.000	228.000	210.000	196.000	190.000	185.500	184.000	183.500
160 FSW	280.000	260.000	238.000	220.000	206.000	200.000	195.500	194.000	193.500
170 FSW	290.000	270.000	248.000	230.000	216.000	210.000	205.500	204.000	203.500
180 FSW	300.000	280.000	258.000	240.000	226.000	220.000	215.500	214.000	213.500
190 FSW	310.000	290.000	268.000	250.000	236.000	230.000	225.500	224.000	223.500
200 FSW	320.000	300.000	278.000	260.000	246.000	240.000	235.500	234.000	233.500
210 FSW	330.000	310.000	288.000	270.000	256.000	250.000	245.500	244.000	243.500
220 FSW	340.000	320.000	298.000	280.000	266.000	260.000	255.500	254.000	253.500
230 FSW	350.000	330.000	308.000	290.000	276.000	270.000	265.500	264.000	263.500
240 FSW	360.000	340.000	318.000	300.000	286.000	280.000	275.500	274.000	273.500
250 FSW	370.000	350.000	328.000	310.000	296.000	290.000	285.500	284.000	283.500
260 FSW	380.000	360.000	338.000	320.000	306.000	300.000	295.500	294.000	293.500
270 FSW	390.000	370.000	348.000	330.000	316.000	310.000	305.500	304.000	303.500
280 FSW	400.000	380.000	358.000	340.000	326.000	320.000	315.500	314.000	313.500
290 FSW	410.000	390.000	368.000	350.000	336.000	330.000	325.500	324.000	323.500
300 FSW	420.000	400.000	378.000	360.000	346.000	340.000	335.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL03- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	130.000	107.000	83.000	68.000	56.000	50.000	45.500	44.000	43.500
20 FSW	140.000	117.000	93.000	78.000	66.000	60.000	55.500	54.000	53.500
30 FSW	150.000	127.000	103.000	88.000	76.000	70.000	65.500	64.000	63.500
40 FSW	160.000	137.000	113.000	98.000	86.000	80.000	75.500	74.000	73.500
50 FSW	170.000	147.000	123.000	108.000	96.000	90.000	85.500	84.000	83.500
60 FSW	180.000	157.000	133.000	118.000	106.000	100.000	95.500	94.000	93.500
70 FSW	190.000	167.000	143.000	128.000	116.000	110.000	105.500	104.000	103.500
80 FSW	200.000	177.000	153.000	138.000	126.000	120.000	115.500	114.000	113.500
90 FSW	210.000	187.000	163.000	148.000	136.000	130.000	125.500	124.000	123.500
100 FSW	220.000	197.000	173.000	158.000	146.000	140.000	135.500	134.000	133.500
110 FSW	230.000	207.000	183.000	168.000	156.000	150.000	145.500	144.000	143.500
120 FSW	240.000	217.000	193.000	178.000	166.000	160.000	155.500	154.000	153.500
130 FSW	250.000	227.000	203.000	188.000	176.000	170.000	165.500	164.000	163.500
140 FSW	260.000	237.000	213.000	198.000	186.000	180.000	175.500	174.000	173.500
150 FSW	270.000	247.000	223.000	208.000	196.000	190.000	185.500	184.000	183.500
160 FSW	280.000	257.000	233.000	218.000	206.000	200.000	195.500	194.000	193.500
170 FSW	290.000	267.000	243.000	228.000	216.000	210.000	205.500	204.000	203.500
180 FSW	300.000	277.000	253.000	238.000	226.000	220.000	215.500	214.000	213.500
190 FSW	310.000	287.000	263.000	248.000	236.000	230.000	225.500	224.000	223.500
200 FSW	320.000	297.000	273.000	258.000	246.000	240.000	235.500	234.000	233.500
210 FSW	330.000	307.000	283.000	268.000	256.000	250.000	245.500	244.000	243.500
220 FSW	340.000	317.000	293.000	278.000	266.000	260.000	255.500	254.000	253.500
230 FSW	350.000	327.000	303.000	288.000	276.000	270.000	265.500	264.000	263.500
240 FSW	360.000	337.000	313.000	298.000	286.000	280.000	275.500	274.000	273.500
250 FSW	370.000	347.000	323.000	308.000	296.000	290.000	285.500	284.000	283.500
260 FSW	380.000	357.000	333.000	318.000	306.000	300.000	295.500	294.000	293.500
270 FSW	390.000	367.000	343.000	328.000	316.000	310.000	305.500	304.000	303.500
280 FSW	400.000	377.000	353.000	338.000	326.000	320.000	315.500	314.000	313.500
290 FSW	410.000	387.000	363.000	348.000	336.000	330.000	325.500	324.000	323.500
300 FSW	420.000	397.000	373.000	358.000	346.000	340.000	335.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL04- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	128.000	103.000	82.000	68.000	56.000	30.000	45.500	44.000	43.500
20 FSW	138.000	113.000	92.000	78.000	66.000	60.000	55.500	54.000	53.500
30 FSW	148.000	123.000	102.000	88.000	76.000	70.000	65.500	64.000	63.500
40 FSW	158.000	133.000	112.000	98.000	86.000	80.000	75.500	74.000	73.500
50 FSW	168.000	143.000	122.000	108.000	96.000	90.000	85.500	84.000	83.500
60 FSW	178.000	153.000	132.000	118.000	106.000	100.000	95.500	94.000	93.500
70 FSW	188.000	163.000	142.000	128.000	116.000	110.000	105.500	104.000	103.500
80 FSW	198.000	173.000	152.000	138.000	126.000	120.000	115.500	114.000	113.500
90 FSW	208.000	183.000	162.000	148.000	136.000	130.000	125.500	124.000	123.500
100 FSW	218.000	193.000	172.000	158.000	146.000	140.000	135.500	134.000	133.500
110 FSW	228.000	203.000	182.000	168.000	156.000	150.000	145.500	144.000	143.500
120 FSW	238.000	213.000	192.000	178.000	166.000	160.000	155.500	154.000	153.500
130 FSW	248.000	223.000	202.000	188.000	176.000	170.000	165.500	164.000	163.500
140 FSW	258.000	233.000	212.000	198.000	186.000	180.000	175.500	174.000	173.500
150 FSW	268.000	243.000	222.000	208.000	196.000	190.000	185.500	184.000	183.500
160 FSW	278.000	253.000	232.000	218.000	206.000	200.000	195.500	194.000	193.500
170 FSW	288.000	263.000	242.000	228.000	216.000	210.000	205.500	204.000	203.500
180 FSW	298.000	273.000	252.000	238.000	226.000	220.000	215.500	214.000	213.500
190 FSW	308.000	283.000	262.000	248.000	236.000	230.000	225.500	224.000	223.500
200 FSW	318.000	293.000	272.000	258.000	246.000	240.000	235.500	234.000	233.500
210 FSW	328.000	303.000	282.000	268.000	256.000	250.000	245.500	244.000	243.500
220 FSW	338.000	313.000	292.000	278.000	266.000	260.000	255.500	254.000	253.500
230 FSW	348.000	323.000	302.000	288.000	276.000	270.000	265.500	264.000	263.500
240 FSW	358.000	333.000	312.000	298.000	286.000	280.000	275.500	274.000	273.500
250 FSW	368.000	343.000	322.000	308.000	296.000	290.000	285.500	284.000	283.500
260 FSW	378.000	353.000	332.000	318.000	306.000	300.000	295.500	294.000	293.500
270 FSW	388.000	363.000	342.000	328.000	316.000	310.000	305.500	304.000	303.500
280 FSW	398.000	373.000	352.000	338.000	326.000	320.000	315.500	314.000	313.500
290 FSW	408.000	383.000	362.000	348.000	336.000	330.000	325.500	324.000	323.500
300 FSW	418.000	393.000	372.000	358.000	346.000	340.000	335.500	334.000	333.500

AD-A125 064 COMPUTER ALGORITHMS USED IN COMPUTING THE MK 15/16 CONSTANT 07 ATA OXYGEN..(U) NAVY EXPERIMENTAL DIVING UNIT PANAMA CITY FL E D THALMANN JAN 83 NEDU-1-83

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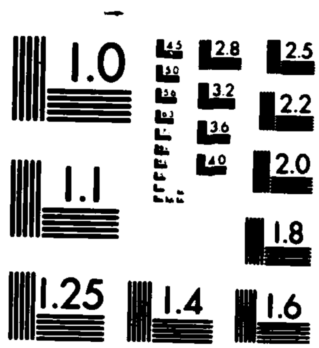

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL05- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	125.000	100.000	82.000	68.000	56.000	50.000	45.500	44.000	43.500
20 FSW	135.000	110.000	92.000	78.000	66.000	60.000	55.500	54.000	53.500
30 FSW	145.000	120.000	102.000	88.000	76.000	70.000	65.500	64.000	63.500
40 FSW	155.000	130.000	112.000	98.000	86.000	80.000	75.500	74.000	73.500
50 FSW	165.000	140.000	122.000	108.000	96.000	90.000	85.500	84.000	83.500
60 FSW	175.000	150.000	132.000	118.000	106.000	100.000	95.500	94.000	93.500
70 FSW	185.000	160.000	142.000	128.000	116.000	110.000	105.500	104.000	103.500
80 FSW	195.000	170.000	152.000	138.000	126.000	120.000	115.500	114.000	113.500
90 FSW	205.000	180.000	162.000	148.000	136.000	130.000	125.500	124.000	123.500
100 FSW	215.000	190.000	172.000	158.000	146.000	140.000	135.500	134.000	133.500
110 FSW	225.000	200.000	182.000	168.000	156.000	150.000	145.500	144.000	143.500
120 FSW	235.000	210.000	192.000	178.000	166.000	160.000	155.500	154.000	153.500
130 FSW	245.000	220.000	202.000	188.000	176.000	170.000	165.500	164.000	163.500
140 FSW	255.000	230.000	212.000	198.000	186.000	180.000	175.500	174.000	173.500
150 FSW	265.000	240.000	222.000	208.000	196.000	190.000	185.500	184.000	183.500
160 FSW	275.000	250.000	232.000	218.000	206.000	200.000	195.500	194.000	193.500
170 FSW	285.000	260.000	242.000	228.000	216.000	210.000	205.500	204.000	203.500
180 FSW	295.000	270.000	252.000	238.000	226.000	220.000	215.500	214.000	213.500
190 FSW	305.000	280.000	262.000	248.000	236.000	230.000	225.500	224.000	223.500
200 FSW	315.000	290.000	272.000	258.000	246.000	240.000	235.500	234.000	233.500
210 FSW	325.000	300.000	282.000	268.000	256.000	250.000	245.500	244.000	243.500
220 FSW	335.000	310.000	292.000	278.000	266.000	260.000	255.500	254.000	253.500
230 FSW	345.000	320.000	302.000	288.000	276.000	270.000	265.500	264.000	263.500
240 FSW	355.000	330.000	312.000	298.000	286.000	280.000	275.500	274.000	273.500
250 FSW	365.000	340.000	322.000	308.000	296.000	290.000	285.500	284.000	283.500
260 FSW	375.000	350.000	332.000	318.000	306.000	300.000	295.500	294.000	293.500
270 FSW	385.000	360.000	342.000	328.000	316.000	310.000	305.500	304.000	303.500
280 FSW	395.000	370.000	352.000	338.000	326.000	320.000	315.500	314.000	313.500
290 FSW	405.000	380.000	362.000	348.000	336.000	330.000	325.500	324.000	323.500
300 FSW	415.000	390.000	372.000	358.000	346.000	340.000	335.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL06- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	90.000	80.000	60.000	56.000	50.000	45.500	44.000	43.500
20 FSW	130.000	100.000	90.000	70.000	66.000	60.000	55.500	54.000	53.500
30 FSW	140.000	110.000	100.000	80.000	76.000	70.000	65.500	64.000	63.500
40 FSW	150.000	120.000	110.000	90.000	86.000	80.000	75.500	74.000	73.500
50 FSW	160.000	130.000	120.000	100.000	96.000	90.000	85.500	84.000	83.500
60 FSW	170.000	140.000	130.000	110.000	106.000	100.000	95.500	94.000	93.500
70 FSW	180.000	150.000	140.000	120.000	116.000	110.000	105.500	104.000	103.500
80 FSW	190.000	160.000	150.000	130.000	126.000	120.000	115.500	114.000	113.500
90 FSW	200.000	170.000	160.000	140.000	136.000	130.000	125.500	124.000	123.500
100 FSW	210.000	180.000	170.000	150.000	146.000	140.000	135.500	134.000	133.500
110 FSW	220.000	190.000	180.000	160.000	156.000	150.000	145.500	144.000	143.500
120 FSW	230.000	200.000	190.000	170.000	166.000	160.000	155.500	154.000	153.500
130 FSW	240.000	210.000	200.000	180.000	176.000	170.000	165.500	164.000	163.500
140 FSW	250.000	220.000	210.000	190.000	186.000	180.000	175.500	174.000	173.500
150 FSW	260.000	230.000	220.000	200.000	196.000	190.000	185.500	184.000	183.500
160 FSW	270.000	240.000	230.000	210.000	206.000	200.000	195.500	194.000	193.500
170 FSW	280.000	250.000	240.000	220.000	216.000	210.000	205.500	204.000	203.500
180 FSW	290.000	260.000	250.000	230.000	226.000	220.000	215.500	214.000	213.500
190 FSW	300.000	270.000	260.000	240.000	236.000	230.000	225.500	224.000	223.500
200 FSW	310.000	280.000	270.000	250.000	246.000	240.000	235.500	234.000	233.500
210 FSW	320.000	290.000	280.000	260.000	256.000	250.000	245.500	244.000	243.500
220 FSW	330.000	300.000	290.000	270.000	266.000	260.000	255.500	254.000	253.500
230 FSW	340.000	310.000	300.000	280.000	276.000	270.000	265.500	264.000	263.500
240 FSW	350.000	320.000	310.000	290.000	286.000	280.000	275.500	274.000	273.500
250 FSW	360.000	330.000	320.000	300.000	296.000	290.000	285.500	284.000	283.500
260 FSW	370.000	340.000	330.000	310.000	306.000	300.000	295.500	294.000	293.500
270 FSW	380.000	350.000	340.000	320.000	316.000	310.000	305.500	304.000	303.500
280 FSW	390.000	360.000	350.000	330.000	326.000	320.000	315.500	314.000	313.500
290 FSW	400.000	370.000	360.000	340.000	336.000	330.000	325.500	324.000	323.500
300 FSW	410.000	380.000	370.000	350.000	346.000	340.000	335.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL07- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	98.000	80.000	68.000	56.000	50.000	49.000	48.000	47.000
20 FSW	132.000	110.000	92.000	80.000	68.000	62.000	61.000	60.000	59.000
30 FSW	144.000	122.000	104.000	92.000	80.000	74.000	73.000	72.000	71.000
40 FSW	156.000	134.000	116.000	104.000	92.000	86.000	85.000	84.000	83.000
50 FSW	168.000	146.000	128.000	116.000	104.000	98.000	97.000	96.000	95.000
60 FSW	180.000	158.000	140.000	128.000	116.000	110.000	109.000	108.000	107.000
70 FSW	192.000	170.000	152.000	140.000	128.000	122.000	121.000	120.000	119.000
80 FSW	204.000	182.000	164.000	152.000	140.000	134.000	133.000	132.000	131.000
90 FSW	216.000	194.000	176.000	164.000	152.000	146.000	145.000	144.000	143.000
100 FSW	228.000	206.000	188.000	176.000	164.000	158.000	157.000	156.000	155.000
110 FSW	240.000	218.000	200.000	188.000	176.000	170.000	169.000	168.000	167.000
120 FSW	252.000	230.000	212.000	200.000	188.000	182.000	181.000	180.000	179.000
130 FSW	264.000	242.000	224.000	212.000	200.000	194.000	193.000	192.000	191.000
140 FSW	276.000	254.000	236.000	224.000	212.000	206.000	205.000	204.000	203.000
150 FSW	288.000	266.000	248.000	236.000	224.000	218.000	217.000	216.000	215.000
160 FSW	300.000	278.000	260.000	248.000	236.000	230.000	229.000	228.000	227.000
170 FSW	312.000	290.000	272.000	260.000	248.000	242.000	241.000	240.000	239.000
180 FSW	324.000	302.000	284.000	272.000	260.000	254.000	253.000	252.000	251.000
190 FSW	336.000	314.000	296.000	284.000	272.000	266.000	265.000	264.000	263.000
200 FSW	348.000	326.000	308.000	296.000	284.000	278.000	277.000	276.000	275.000
210 FSW	360.000	338.000	320.000	308.000	296.000	290.000	289.000	288.000	287.000
220 FSW	372.000	350.000	332.000	320.000	308.000	302.000	301.000	300.000	299.000
230 FSW	384.000	362.000	344.000	332.000	320.000	314.000	313.000	312.000	311.000
240 FSW	396.000	374.000	356.000	344.000	332.000	326.000	325.000	324.000	323.000
250 FSW	408.000	386.000	368.000	356.000	344.000	338.000	337.000	336.000	335.000
260 FSW	420.000	398.000	380.000	368.000	356.000	350.000	349.000	348.000	347.000
270 FSW	432.000	410.000	392.000	380.000	368.000	362.000	361.000	360.000	359.000
280 FSW	444.000	422.000	404.000	392.000	380.000	374.000	373.000	372.000	371.000
290 FSW	456.000	434.000	416.000	404.000	392.000	386.000	385.000	384.000	383.000
300 FSW	468.000	446.000	428.000	416.000	404.000	398.000	397.000	396.000	395.000

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL09- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	98.000	80.000	68.000	56.000	48.000	47.500	47.000	46.000
20 FSW	132.000	110.000	92.000	80.000	68.000	60.000	59.500	59.000	58.000
30 FSW	144.000	122.000	104.000	92.000	80.000	72.000	71.500	71.000	70.000
40 FSW	156.000	134.000	116.000	104.000	92.000	84.000	83.500	83.000	82.000
50 FSW	168.000	146.000	128.000	116.000	104.000	96.000	95.500	95.000	94.000
60 FSW	180.000	158.000	140.000	128.000	116.000	108.000	107.500	107.000	106.000
70 FSW	192.000	170.000	152.000	140.000	128.000	120.000	119.500	119.000	118.000
80 FSW	204.000	182.000	164.000	152.000	140.000	132.000	131.500	131.000	130.000
90 FSW	216.000	194.000	176.000	164.000	152.000	144.000	143.500	143.000	142.000
100 FSW	228.000	206.000	188.000	176.000	164.000	156.000	155.500	155.000	154.000
110 FSW	240.000	218.000	200.000	188.000	176.000	168.000	167.500	167.000	166.000
120 FSW	252.000	230.000	212.000	200.000	188.000	180.000	179.500	179.000	178.000
130 FSW	264.000	242.000	224.000	212.000	200.000	192.000	191.500	191.000	190.000
140 FSW	276.000	254.000	236.000	224.000	212.000	204.000	203.500	203.000	202.000
150 FSW	288.000	266.000	248.000	236.000	224.000	216.000	215.500	215.000	214.000
160 FSW	300.000	278.000	260.000	248.000	236.000	228.000	227.500	227.000	226.000
170 FSW	312.000	290.000	272.000	260.000	248.000	240.000	239.500	239.000	238.000
180 FSW	324.000	302.000	284.000	272.000	260.000	252.000	251.500	251.000	250.000
190 FSW	336.000	314.000	296.000	284.000	272.000	264.000	263.500	263.000	262.000
200 FSW	348.000	326.000	308.000	296.000	284.000	276.000	275.500	275.000	274.000
210 FSW	360.000	338.000	320.000	308.000	296.000	288.000	287.500	287.000	286.000
220 FSW	372.000	350.000	332.000	320.000	308.000	300.000	299.500	299.000	298.000
230 FSW	384.000	362.000	344.000	332.000	320.000	312.000	311.500	311.000	310.000
240 FSW	396.000	374.000	356.000	344.000	332.000	324.000	323.500	323.000	322.000
250 FSW	408.000	386.000	368.000	356.000	344.000	336.000	335.500	335.000	334.000
260 FSW	420.000	398.000	380.000	368.000	356.000	348.000	347.500	347.000	346.000
270 FSW	432.000	410.000	392.000	380.000	368.000	360.000	359.500	359.000	358.000
280 FSW	444.000	422.000	404.000	392.000	380.000	372.000	371.500	371.000	370.000
290 FSW	456.000	434.000	416.000	404.000	392.000	384.000	383.500	383.000	382.000
300 FSW	468.000	446.000	428.000	416.000	404.000	396.000	395.500	395.000	394.000

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(NVAL11- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN .91 SDR	20 MIN .83 SDR	40 MIN .83 SDR	80 MIN .83 SDR	120 MIN .83 SDR
10 FSW	120.000	98.000	82.000	68.000	56.000	50.000
20 FSW	132.000	110.000	94.000	80.000	68.000	62.000
30 FSW	144.000	122.000	106.000	92.000	80.000	74.000
40 FSW	156.000	134.000	118.000	104.000	92.000	86.000
50 FSW	168.000	146.000	130.000	116.000	104.000	98.000
60 FSW	180.000	158.000	142.000	128.000	116.000	110.000
70 FSW	192.000	170.000	154.000	140.000	128.000	122.000
80 FSW	204.000	182.000	166.000	152.000	140.000	134.000
90 FSW	216.000	194.000	178.000	164.000	152.000	146.000
100 FSW	228.000	206.000	190.000	176.000	164.000	158.000
110 FSW	240.000	218.000	202.000	188.000	176.000	170.000
120 FSW	252.000	230.000	214.000	200.000	188.000	182.000
130 FSW	264.000	242.000	226.000	212.000	200.000	194.000
140 FSW	276.000	254.000	238.000	224.000	212.000	206.000
150 FSW	288.000	266.000	250.000	236.000	224.000	218.000
160 FSW	300.000	278.000	262.000	248.000	236.000	230.000
170 FSW	312.000	290.000	274.000	260.000	248.000	242.000
180 FSW	324.000	302.000	286.000	272.000	260.000	254.000
190 FSW	336.000	314.000	298.000	284.000	272.000	266.000
200 FSW	348.000	326.000	310.000	296.000	284.000	278.000
210 FSW	360.000	338.000	322.000	308.000	296.000	290.000
220 FSW	372.000	350.000	334.000	320.000	308.000	302.000
230 FSW	384.000	362.000	346.000	332.000	320.000	314.000
240 FSW	396.000	374.000	358.000	344.000	332.000	326.000
250 FSW	408.000	386.000	370.000	356.000	344.000	338.000
260 FSW	420.000	398.000	382.000	368.000	356.000	350.000
270 FSW	432.000	410.000	394.000	380.000	368.000	362.000
280 FSW	444.000	422.000	406.000	392.000	380.000	374.000
290 FSW	456.000	434.000	418.000	404.000	392.000	386.000
300 FSW	468.000	446.000	430.000	416.000	404.000	398.000

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL12- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN .63 SDR	10 MIN .66 SDR	20 MIN .71 SDR	40 MIN .83 SDR	80 MIN .83 SDR	120 MIN .83 SDR
10 FSW	120.000	98.000	82.000	68.000	56.000	50.000
20 FSW	132.000	110.000	94.000	80.000	68.000	62.000
30 FSW	144.000	122.000	106.000	92.000	80.000	74.000
40 FSW	156.000	134.000	118.000	104.000	92.000	86.000
50 FSW	168.000	146.000	130.000	116.000	104.000	98.000
60 FSW	180.000	158.000	142.000	128.000	116.000	110.000
70 FSW	192.000	170.000	154.000	140.000	128.000	122.000
80 FSW	204.000	182.000	166.000	152.000	140.000	134.000
90 FSW	216.000	194.000	178.000	164.000	152.000	146.000
100 FSW	228.000	206.000	190.000	176.000	164.000	158.000
110 FSW	240.000	218.000	202.000	188.000	176.000	170.000
120 FSW	252.000	230.000	214.000	200.000	188.000	182.000
130 FSW	264.000	242.000	226.000	212.000	200.000	194.000
140 FSW	276.000	254.000	238.000	224.000	212.000	206.000
150 FSW	288.000	266.000	250.000	236.000	224.000	218.000
160 FSW	300.000	278.000	262.000	248.000	236.000	230.000
170 FSW	312.000	290.000	274.000	260.000	248.000	242.000
180 FSW	324.000	302.000	286.000	272.000	260.000	254.000
190 FSW	336.000	314.000	298.000	284.000	272.000	266.000
200 FSW	348.000	326.000	310.000	296.000	284.000	278.000
210 FSW	360.000	338.000	322.000	308.000	296.000	290.000
220 FSW	372.000	350.000	334.000	320.000	308.000	302.000
230 FSW	384.000	362.000	346.000	332.000	320.000	314.000
240 FSW	396.000	374.000	358.000	344.000	332.000	326.000
250 FSW	408.000	386.000	370.000	356.000	344.000	338.000
260 FSW	420.000	398.000	382.000	368.000	356.000	350.000
270 FSW	432.000	410.000	394.000	380.000	368.000	362.000
280 FSW	444.000	422.000	406.000	392.000	380.000	374.000
290 FSW	456.000	434.000	418.000	404.000	392.000	386.000
300 FSW	468.000	446.000	430.000	416.000	404.000	398.000

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(HVAL13- HELIUM)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN .83 SDR	20 MIN .71 SDR	40 MIN .83 SDR	80 MIN .83 SDR	120 MIN .83 SDR			
10 FSW	120.000	98.000	82.000	68.000	56.000	50.000			
20 FSW	132.000	110.000	94.000	80.000	68.000	62.000			
30 FSW	144.000	122.000	106.000	92.000	80.000	74.000			
40 FSW	156.000	134.000	118.000	104.000	92.000	86.000			
50 FSW	168.000	146.000	130.000	116.000	104.000	98.000			
60 FSW	180.000	158.000	142.000	128.000	116.000	110.000			
70 FSW	192.000	170.000	154.000	140.000	128.000	122.000			
80 FSW	204.000	182.000	166.000	152.000	140.000	134.000			
90 FSW	216.000	194.000	178.000	164.000	152.000	146.000			
100 FSW	228.000	206.000	190.000	176.000	164.000	158.000			
110 FSW	240.000	218.000	202.000	188.000	176.000	170.000			
120 FSW	252.000	230.000	214.000	200.000	188.000	182.000			
130 FSW	264.000	242.000	226.000	212.000	200.000	194.000			
140 FSW	276.000	254.000	238.000	224.000	212.000	206.000			
150 FSW	288.000	266.000	250.000	236.000	224.000	218.000			
160 FSW	300.000	278.000	262.000	248.000	236.000	230.000			
170 FSW	312.000	290.000	274.000	260.000	248.000	242.000			
180 FSW	324.000	302.000	286.000	272.000	260.000	254.000			
190 FSW	336.000	314.000	298.000	284.000	272.000	266.000			
200 FSW	348.000	326.000	310.000	296.000	284.000	278.000			
210 FSW	360.000	338.000	322.000	308.000	296.000	290.000			
220 FSW	372.000	350.000	334.000	320.000	308.000	302.000			
230 FSW	384.000	362.000	346.000	332.000	320.000	314.000			
240 FSW	396.000	374.000	358.000	344.000	332.000	326.000			
250 FSW	408.000	386.000	370.000	356.000	344.000	338.000			
260 FSW	420.000	398.000	382.000	368.000	356.000	350.000			
270 FSW	432.000	410.000	394.000	380.000	368.000	362.000			
280 FSW	444.000	422.000	406.000	392.000	380.000	374.000			
290 FSW	456.000	434.000	418.000	404.000	392.000	386.000			
300 FSW	468.000	446.000	430.000	416.000	404.000	398.000			

ANNEX C-6

MCOMP VERSION 2.0
ASCENT CRITERIA

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL1 - NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	91.245	78.731	67.000	55.790	51.358	49.533	49.272	48.490	46.926
20 FSW	110.980	96.416	82.613	69.201	63.967	61.771	61.457	60.515	58.627
30 FSW	131.714	114.663	98.482	82.814	76.556	73.968	73.598	72.406	70.259
40 FSW	152.405	132.885	114.273	96.234	89.023	86.040	85.613	84.331	81.764
50 FSW	173.132	150.976	129.928	109.519	101.358	97.981	97.497	96.046	93.138
60 FSW	193.617	168.913	145.440	122.673	113.567	109.798	109.258	107.639	104.394
70 FSW	213.936	186.698	160.814	135.704	125.660	121.502	120.906	119.120	115.540
80 FSW	234.094	204.339	176.060	148.623	137.647	133.103	132.452	130.500	126.587
90 FSW	254.102	221.845	191.186	161.439	149.537	144.611	143.905	141.788	137.545
100 FSW	273.969	239.225	206.203	174.160	161.339	156.032	155.271	152.991	148.420
110 FSW	293.703	256.489	221.118	186.794	173.059	167.373	166.559	164.116	159.219
120 FSW	313.315	273.645	235.937	199.346	184.703	178.642	177.773	175.168	169.948
130 FSW	332.811	290.698	250.668	211.822	196.277	189.841	188.919	186.154	180.611
140 FSW	352.199	307.656	265.317	224.228	207.785	200.977	200.002	197.077	191.214
150 FSW	371.485	324.525	279.887	236.567	219.231	212.054	211.025	207.941	201.760
160 FSW	390.675	341.310	294.385	248.844	230.619	223.074	221.993	218.750	212.252
170 FSW	409.774	358.014	308.813	261.062	241.952	234.041	232.907	229.508	222.693
180 FSW	428.787	374.643	323.175	273.224	253.234	244.957	243.772	240.215	233.087
190 FSW	447.719	391.201	337.475	285.334	264.466	255.827	254.589	250.876	243.435
200 FSW	466.572	407.690	351.717	297.393	275.652	266.651	265.361	261.493	253.741
210 FSW	485.351	424.114	365.901	309.404	286.793	277.432	276.090	272.068	264.005
220 FSW	504.059	440.476	380.032	321.369	297.892	288.171	286.779	282.602	274.230
230 FSW	522.700	456.778	394.112	333.291	308.950	298.872	297.428	293.097	284.417
240 FSW	541.275	473.023	408.142	345.171	319.969	309.535	308.040	303.556	294.569
250 FSW	559.787	489.213	422.124	357.010	330.950	320.161	318.615	313.979	304.686
260 FSW	578.240	505.351	436.061	368.811	341.896	330.753	329.156	324.368	314.770
270 FSW	596.634	521.438	449.954	380.575	352.807	341.311	339.664	334.724	324.822
280 FSW	614.973	537.475	463.805	392.303	363.685	351.838	350.140	345.049	334.844
290 FSW	633.257	553.466	477.615	403.996	374.531	362.332	360.585	355.343	344.836
300 FSW	651.490	569.411	491.385	415.655	385.346	372.798	371.000	365.607	354.799

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL2 - NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	86.031	74.821	64.393	55.790	50.054	48.229	47.969	47.187	45.623
20 FSW	104.934	91.831	79.526	69.281	62.399	60.200	59.886	58.942	57.052
30 FSW	124.634	109.292	94.857	82.814	74.708	72.115	71.745	70.631	68.400
40 FSW	144.348	126.709	110.101	96.234	86.893	83.903	83.477	82.192	79.619
50 FSW	163.935	143.993	125.209	109.519	98.946	95.561	95.078	93.624	90.710
60 FSW	183.363	161.125	140.177	122.673	110.875	107.098	106.559	104.936	101.683
70 FSW	202.630	178.111	155.010	135.704	122.690	118.523	117.928	116.138	112.549
80 FSW	221.744	194.958	169.718	148.623	134.402	129.848	129.198	127.241	123.319
90 FSW	240.713	211.675	184.311	161.439	146.019	141.080	140.376	138.254	134.000
100 FSW	259.548	228.271	198.797	174.160	157.549	152.229	151.469	149.184	144.601
110 FSW	278.258	244.756	213.104	186.794	168.998	163.299	162.486	160.037	155.128
120 FSW	296.850	261.137	227.400	199.346	180.374	174.298	173.431	170.820	165.586
130 FSW	315.332	277.420	241.690	211.822	191.681	185.230	184.309	181.537	175.981
140 FSW	333.712	293.612	255.820	224.228	202.923	196.100	195.126	192.194	186.316
150 FSW	351.995	309.719	269.875	236.567	214.105	206.911	205.884	202.793	196.596
160 FSW	370.186	325.744	283.859	248.844	225.230	217.667	216.588	213.338	206.823
170 FSW	388.292	341.694	297.777	261.062	236.302	228.372	227.240	223.832	217.001
180 FSW	406.316	357.571	311.631	273.224	247.323	239.027	237.843	234.278	227.132
190 FSW	424.262	373.380	325.425	285.334	258.296	249.636	248.400	244.679	237.219
200 FSW	442.134	389.124	339.162	297.393	269.223	260.201	258.913	255.036	247.264
210 FSW	459.935	404.805	352.844	309.404	280.107	270.724	269.384	265.352	257.269
220 FSW	477.670	420.427	366.475	321.369	290.950	281.206	279.816	275.629	267.236
230 FSW	495.340	435.991	380.055	333.291	301.752	291.651	290.209	285.868	277.166
240 FSW	512.948	451.582	393.589	345.171	312.517	302.058	300.565	296.070	287.061
250 FSW	530.496	466.960	407.076	357.010	323.245	312.430	310.886	306.239	296.923
260 FSW	547.980	482.367	420.519	368.811	333.938	322.768	321.174	316.374	306.752
270 FSW	565.425	497.727	433.920	380.575	344.597	333.074	331.429	326.477	316.550
280 FSW	582.808	513.039	447.280	392.303	355.224	343.348	341.653	336.549	326.310
290 FSW	600.141	528.307	460.601	403.996	365.819	353.591	351.846	346.591	336.058
300 FSW	617.424	543.531	473.884	415.655	376.384	363.806	362.010	356.605	345.769

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL3 - NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	80.817	70.910	61.786	53.183	48.751	46.926	46.665	45.883	44.319
20 FSW	98.855	87.230	76.431	66.158	60.829	58.627	58.312	57.366	55.473
30 FSW	117.520	103.898	91.221	79.137	72.857	70.259	69.887	68.772	66.536
40 FSW	136.170	120.505	105.916	91.998	84.759	81.764	81.334	80.047	77.468
50 FSW	154.689	136.976	120.474	104.725	96.530	93.138	92.652	91.195	88.274
60 FSW	173.053	153.300	134.895	117.324	108.179	104.394	103.851	102.224	98.964
70 FSW	191.263	169.482	149.185	129.805	119.716	115.540	114.941	113.147	109.549
80 FSW	209.326	185.530	163.353	142.176	131.152	126.587	125.933	123.972	120.040
90 FSW	227.252	201.454	177.410	154.449	142.495	137.545	136.836	134.708	130.445
100 FSW	245.049	217.263	191.364	166.630	153.752	148.420	147.656	145.364	140.771
110 FSW	262.727	232.964	205.222	178.727	164.931	159.219	158.400	155.945	151.024
120 FSW	280.294	248.567	218.992	190.746	176.038	169.948	169.075	166.458	161.211
130 FSW	297.758	264.076	232.679	202.692	187.077	180.611	179.685	176.906	171.336
140 FSW	315.123	279.498	246.289	214.570	198.054	191.214	190.234	187.295	181.402
150 FSW	332.397	294.838	259.827	226.385	208.971	201.760	200.726	197.627	191.415
160 FSW	349.585	310.102	273.296	238.140	219.833	212.252	211.166	207.907	201.376
170 FSW	366.691	325.292	286.701	249.838	230.643	222.693	221.554	218.138	211.289
180 FSW	383.720	340.414	300.044	261.483	241.403	233.087	231.895	228.322	221.157
190 FSW	400.675	355.470	313.330	273.078	252.116	243.435	242.191	238.461	230.982
200 FSW	417.561	370.464	326.561	284.624	262.785	253.741	252.445	248.558	240.766
210 FSW	434.380	385.399	339.739	296.124	273.411	264.005	262.657	258.614	250.511
220 FSW	451.135	400.277	352.867	307.581	283.997	274.230	272.830	268.633	260.218
230 FSW	467.829	415.101	365.948	318.995	294.543	284.417	282.966	278.614	269.890
240 FSW	484.464	429.873	378.982	330.369	305.053	294.369	293.067	288.561	279.528
250 FSW	501.044	444.595	391.972	341.705	315.527	304.606	303.133	298.473	289.133
260 FSW	517.570	459.269	404.920	353.004	325.967	314.770	313.166	308.353	298.707
270 FSW	534.043	473.897	417.827	364.267	336.374	324.822	323.167	318.202	308.250
280 FSW	550.467	488.481	430.695	375.495	346.749	334.844	333.138	328.021	317.764
290 FSW	566.842	503.021	443.525	386.691	357.093	344.836	343.079	337.811	327.250
300 FSW	583.171	517.520	456.318	397.854	367.408	354.799	352.992	347.573	336.709

ANNEX C-7

MCOMP VERSION 2.1
ASCENT CRITERIA

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL5 - NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000
20 FSW	62.463	62.463	62.463	62.463	62.463	62.463	62.463	62.463	62.463
30 FSW	74.988	74.988	74.988	74.988	74.988	74.988	74.988	74.988	74.988
40 FSW	87.543	87.543	87.543	87.543	87.543	87.543	87.543	87.543	87.543
50 FSW	100.105	100.105	100.105	100.105	100.105	100.105	100.105	100.105	100.105
60 FSW	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655
70 FSW	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180
80 FSW	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669
90 FSW	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117
100 FSW	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895
110 FSW	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245
120 FSW	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595
130 FSW	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945
140 FSW	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295
150 FSW	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645
160 FSW	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995
170 FSW	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345
180 FSW	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695
190 FSW	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045
200 FSW	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395
210 FSW	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745
220 FSW	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095
230 FSW	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445
240 FSW	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795
250 FSW	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145
260 FSW	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495
270 FSW	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845
280 FSW	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195
290 FSW	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545
300 FSW	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL83- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	103.000	85.000	71.000	57.000	46.740	46.740	46.740	46.740	46.740
20 FSW	104.933	85.850	73.000	61.480	61.480	61.480	61.480	61.480	61.480
30 FSW	106.860	86.700	74.988	74.988	74.988	74.988	74.988	74.988	74.988
40 FSW	108.790	87.543	87.543	87.543	87.543	87.543	87.543	87.543	87.543
50 FSW	110.720	100.105	100.105	100.105	100.105	100.105	100.105	100.105	100.105
60 FSW	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655
70 FSW	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180
80 FSW	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669
90 FSW	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117
100 FSW	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895
110 FSW	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245
120 FSW	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595
130 FSW	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945
140 FSW	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295
150 FSW	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645
160 FSW	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995
170 FSW	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345
180 FSW	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695
190 FSW	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045
200 FSW	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395
210 FSW	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745
220 FSW	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095
230 FSW	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445
240 FSW	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795
250 FSW	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145
260 FSW	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495
270 FSW	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845
280 FSW	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195
290 FSW	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545
300 FSW	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(NVAL92- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	103.000	85.000	71.000	56.000	46.740	43.000	40.500	40.500	40.500
20 FSW	104.933	85.850	73.000	61.480	55.000	51.000	51.000	51.000	51.000
30 FSW	106.860	86.700	74.988	74.988	74.988	74.988	74.988	74.988	74.988
40 FSW	108.790	87.543	87.543	87.543	87.543	87.543	87.543	87.543	87.543
50 FSW	110.720	100.105	100.105	100.105	100.105	100.105	100.105	100.105	100.105
60 FSW	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655
70 FSW	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180
80 FSW	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669
90 FSW	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117
100 FSW	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895
110 FSW	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245
120 FSW	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595
130 FSW	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945
140 FSW	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295
150 FSW	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645
160 FSW	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995
170 FSW	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345
180 FSW	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695
190 FSW	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045
200 FSW	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395
210 FSW	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745
220 FSW	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095
230 FSW	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445
240 FSW	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795
250 FSW	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145
260 FSW	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495
270 FSW	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845
280 FSW	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195
290 FSW	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545
300 FSW	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(MVAL97- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	103.000	85.000	71.000	56.000	46.000	46.000	46.000	45.800	45.000
20 FSW	104.933	85.850	73.000	62.500	61.500	57.000	55.000	52.500	51.000
30 FSW	106.860	86.700	74.988	74.988	74.988	74.988	74.988	74.988	74.988
40 FSW	108.790	87.543	87.543	87.543	87.543	87.543	87.543	87.543	87.543
50 FSW	110.720	100.105	100.105	100.105	100.105	100.105	100.105	100.105	100.105
60 FSW	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655	112.655
70 FSW	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180	125.180
80 FSW	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669	137.669
90 FSW	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117	150.117
100 FSW	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895	156.895
110 FSW	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245	167.245
120 FSW	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595	177.595
130 FSW	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945	187.945
140 FSW	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295	198.295
150 FSW	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645	208.645
160 FSW	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995	218.995
170 FSW	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345	229.345
180 FSW	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695	239.695
190 FSW	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045	250.045
200 FSW	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395	260.395
210 FSW	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745	270.745
220 FSW	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095	281.095
230 FSW	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445	291.445
240 FSW	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795	301.795
250 FSW	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145	312.145
260 FSW	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495	322.495
270 FSW	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845	332.845
280 FSW	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195	343.195
290 FSW	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545	353.545
300 FSW	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895	363.895

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(VVAL09- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	103.000	87.000	72.000	56.000	45.500	45.000	44.500	44.000	43.500
20 FSW	113.000	97.000	82.000	66.000	55.500	55.000	54.500	54.000	53.500
30 FSW	123.000	107.000	92.000	76.000	65.500	65.000	64.500	64.000	63.500
40 FSW	133.000	117.000	102.000	86.000	75.500	75.000	74.500	74.000	73.500
50 FSW	143.000	127.000	112.000	96.000	85.500	85.000	84.500	84.000	83.500
60 FSW	153.000	137.000	122.000	106.000	95.500	95.000	94.500	94.000	93.500
70 FSW	163.000	147.000	132.000	116.000	105.500	105.000	104.500	104.000	103.500
80 FSW	173.000	157.000	142.000	126.000	115.500	115.000	114.500	114.000	113.500
90 FSW	183.000	167.000	152.000	136.000	125.500	125.000	124.500	124.000	123.500
100 FSW	193.000	177.000	162.000	146.000	135.500	135.000	134.500	134.000	133.500
110 FSW	203.000	187.000	172.000	156.000	145.500	145.000	144.500	144.000	143.500
120 FSW	213.000	197.000	182.000	166.000	155.500	155.000	154.500	154.000	153.500
130 FSW	223.000	207.000	192.000	176.000	165.500	165.000	164.500	164.000	163.500
140 FSW	233.000	217.000	202.000	186.000	175.500	175.000	174.500	174.000	173.500
150 FSW	243.000	227.000	212.000	196.000	185.500	185.000	184.500	184.000	183.500
160 FSW	253.000	237.000	222.000	206.000	195.500	195.000	194.500	194.000	193.500
170 FSW	263.000	247.000	232.000	216.000	205.500	205.000	204.500	204.000	203.500
180 FSW	273.000	257.000	242.000	226.000	215.500	215.000	214.500	214.000	213.500
190 FSW	283.000	267.000	252.000	236.000	225.500	225.000	224.500	224.000	223.500
200 FSW	293.000	277.000	262.000	246.000	235.500	235.000	234.500	234.000	233.500
210 FSW	303.000	287.000	272.000	256.000	245.500	245.000	244.500	244.000	243.500
220 FSW	313.000	297.000	282.000	266.000	255.500	255.000	254.500	254.000	253.500
230 FSW	323.000	307.000	292.000	276.000	265.500	265.000	264.500	264.000	263.500
240 FSW	333.000	317.000	302.000	286.000	275.500	275.000	274.500	274.000	273.500
250 FSW	343.000	327.000	312.000	296.000	285.500	285.000	284.500	284.000	283.500
260 FSW	353.000	337.000	322.000	306.000	295.500	295.000	294.500	294.000	293.500
270 FSW	363.000	347.000	332.000	316.000	305.500	305.000	304.500	304.000	303.500
280 FSW	373.000	357.000	342.000	326.000	315.500	315.000	314.500	314.000	313.500
290 FSW	383.000	367.000	352.000	336.000	325.500	325.000	324.500	324.000	323.500
300 FSW	393.000	377.000	362.000	346.000	335.500	335.000	334.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(VVAL14- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	90.000	70.000	50.000	40.500	45.500	44.500	44.000	43.500
20 FSW	130.000	100.000	80.000	60.000	50.500	55.500	54.500	54.000	53.500
30 FSW	140.000	110.000	90.000	70.000	60.500	65.500	64.500	64.000	63.500
40 FSW	150.000	120.000	100.000	80.000	70.500	75.500	74.500	74.000	73.500
50 FSW	160.000	130.000	110.000	90.000	80.500	85.500	84.500	84.000	83.500
60 FSW	170.000	140.000	120.000	100.000	90.500	95.500	94.500	94.000	93.500
70 FSW	180.000	150.000	130.000	110.000	100.500	105.500	104.500	104.000	103.500
80 FSW	190.000	160.000	140.000	120.000	110.500	115.500	114.500	114.000	113.500
90 FSW	200.000	170.000	150.000	130.000	120.500	125.500	124.500	124.000	123.500
100 FSW	210.000	180.000	160.000	140.000	130.500	135.500	134.500	134.000	133.500
110 FSW	220.000	190.000	170.000	150.000	140.500	145.500	144.500	144.000	143.500
120 FSW	230.000	200.000	180.000	160.000	150.500	155.500	154.500	154.000	153.500
130 FSW	240.000	210.000	190.000	170.000	160.500	165.500	164.500	164.000	163.500
140 FSW	250.000	220.000	200.000	180.000	170.500	175.500	174.500	174.000	173.500
150 FSW	260.000	230.000	210.000	190.000	180.500	185.500	184.500	184.000	183.500
160 FSW	270.000	240.000	220.000	200.000	190.500	195.500	194.500	194.000	193.500
170 FSW	280.000	250.000	230.000	210.000	200.500	205.500	204.500	204.000	203.500
180 FSW	290.000	260.000	240.000	220.000	210.500	215.500	214.500	214.000	213.500
190 FSW	300.000	270.000	250.000	230.000	220.500	225.500	224.500	224.000	223.500
200 FSW	310.000	280.000	260.000	240.000	230.500	235.500	234.500	234.000	233.500
210 FSW	320.000	290.000	270.000	250.000	240.500	245.500	244.500	244.000	243.500
220 FSW	330.000	300.000	280.000	260.000	250.500	255.500	254.500	254.000	253.500
230 FSW	340.000	310.000	290.000	270.000	260.500	265.500	264.500	264.000	263.500
240 FSW	350.000	320.000	300.000	280.000	270.500	275.500	274.500	274.000	273.500
250 FSW	360.000	330.000	310.000	290.000	280.500	285.500	284.500	284.000	283.500
260 FSW	370.000	340.000	320.000	300.000	290.500	295.500	294.500	294.000	293.500
270 FSW	380.000	350.000	330.000	310.000	300.500	305.500	304.500	304.000	303.500
280 FSW	390.000	360.000	340.000	320.000	310.500	315.500	314.500	314.000	313.500
290 FSW	400.000	370.000	350.000	330.000	320.500	325.500	324.500	324.000	323.500
300 FSW	410.000	380.000	360.000	340.000	330.500	335.500	334.500	334.000	333.500

TABLE OF MAXIMUM PERMISSIBLE TISSUE TENSIONS

(VVAL18- NITROGEN)

TISSUE HALF-TIMES

DEPTH	5 MIN 1.00 SDR	10 MIN 1.00 SDR	20 MIN 1.00 SDR	40 MIN 1.00 SDR	80 MIN 1.00 SDR	120 MIN 1.00 SDR	160 MIN 1.00 SDR	200 MIN 1.00 SDR	240 MIN 1.00 SDR
10 FSW	120.000	90.000	70.000	56.000	48.500	45.500	44.500	44.000	43.500
20 FSW	130.000	100.000	80.000	66.000	58.500	55.500	54.500	54.000	53.500
30 FSW	140.000	110.000	90.000	76.000	68.500	65.500	64.500	64.000	63.500
40 FSW	150.000	120.000	100.000	86.000	78.500	75.500	74.500	74.000	73.500
50 FSW	160.000	130.000	110.000	96.000	88.500	85.500	84.500	84.000	83.500
60 FSW	170.000	140.000	120.000	106.000	98.500	95.500	94.500	94.000	93.500
70 FSW	180.000	150.000	130.000	116.000	108.500	105.500	104.500	104.000	103.500
80 FSW	190.000	160.000	140.000	126.000	118.500	115.500	114.500	114.000	113.500
90 FSW	200.000	170.000	150.000	136.000	128.500	125.500	124.500	124.000	123.500
100 FSW	210.000	180.000	160.000	146.000	138.500	135.500	134.500	134.000	133.500
110 FSW	220.000	190.000	170.000	156.000	148.500	145.500	144.500	144.000	143.500
120 FSW	230.000	200.000	180.000	166.000	158.500	155.500	154.500	154.000	153.500
130 FSW	240.000	210.000	190.000	176.000	168.500	165.500	164.500	164.000	163.500
140 FSW	250.000	220.000	200.000	186.000	178.500	175.500	174.500	174.000	173.500
150 FSW	260.000	230.000	210.000	196.000	188.500	185.500	184.500	184.000	183.500
160 FSW	270.000	240.000	220.000	206.000	198.500	195.500	194.500	194.000	193.500
170 FSW	280.000	250.000	230.000	216.000	208.500	205.500	204.500	204.000	203.500
180 FSW	290.000	260.000	240.000	226.000	218.500	215.500	214.500	214.000	213.500
190 FSW	300.000	270.000	250.000	236.000	228.500	225.500	224.500	224.000	223.500
200 FSW	310.000	280.000	260.000	246.000	238.500	235.500	234.500	234.000	233.500
210 FSW	320.000	290.000	270.000	256.000	248.500	245.500	244.500	244.000	243.500
220 FSW	330.000	300.000	280.000	266.000	258.500	255.500	254.500	254.000	253.500
230 FSW	340.000	310.000	290.000	276.000	268.500	265.500	264.500	264.000	263.500
240 FSW	350.000	320.000	300.000	286.000	278.500	275.500	274.500	274.000	273.500
250 FSW	360.000	330.000	310.000	296.000	288.500	285.500	284.500	284.000	283.500
260 FSW	370.000	340.000	320.000	306.000	298.500	295.500	294.500	294.000	293.500
270 FSW	380.000	350.000	330.000	316.000	308.500	305.500	304.500	304.000	303.500
280 FSW	390.000	360.000	340.000	326.000	318.500	315.500	314.500	314.000	313.500
290 FSW	400.000	370.000	350.000	336.000	328.500	325.500	324.500	324.000	323.500
300 FSW	410.000	380.000	360.000	346.000	338.500	335.500	334.500	334.000	333.500

ANNEX D

SUBROUTINE FMPER
LISTING

&FMPER T=00004 IS ON CR00012 USING 00021 BLKS R=0000

```
FTN4
C
C    Name:  FMPER
C
C    Date:  27 July 1978              Operating System: HP 21MX  RTE IV-B
C                                       Subroutine Size:  533 words
C            17 Aug. 1982               Message buffer added
C
C    Author:  Mark Mobley
C                      Navy Experimental Diving Unit
C                      Panama City, Florida
C
C    Source
C      File:  &FMPER
C
C    Calling
C    Sequence:  (IERR,NAM,LU,MESS)
C                   IERR - FMP error code from calling program.
C                   NAM  - Name of calling program.
C                   LU   - Logical unit no. of terminal.
C                   MESS - Message buffer (any length)
C
C    Arguments:
C
C      IASCI           ASCII ERROR CODE
C      IBUFF           MEMORY BUFFER FOR DISK FILE
C      IDCB            DISK FILE DATA CONTROL BLOCK
C      IEC             BINARY VALUE OF ERROR CODE
C      IER             ERROR CODE FOR FMPER INPUT FILE
C      IERR            ERROR CODE FROM CALLING PROGRAM
C      IPERR           POSITIVE VALUE OF BINARY ERREO CODE
C      ISIGN           SIGN VALUE OF BINARY NUMBER
C      LDASH           BINARY VALUE FOR DASH AND A NULL
C      LEFT            LEFT HALF OF AN ASCII WORD
C      LEN             ACTUAL NUMER OF WORDS READ
C      LU              DEVICE NUMBER OF TERMINAL
C      MESS            OPTIONAL MESSAGE BUFFER
C      NAM             NAM OF CALLING PROGRAM OR SUBROUTINE
C      NAME            NAME OF FILE CONTAINING ERROR DESCRIPTIONS
C      PGERR           TERMINAL DISPLAY BUFFER
C      RIGHT           RIGHT HALF OF ASCII WORD
C      SUBER           DISPLAY LABEL BUFFER
C
C
C    RTE IV-B Operating System Subroutines required:
C
C      CLOSE           CLOSES DISK FILE
C      CNUMD           CONVERTS BINARY NUMBER TO ASCII
C      OPEN            OPENS DISK FILE
C      READF           READS DATA FORM DISK FILE INTO MEMORY BUFFER
C      REIO            WRITES DIRECTLY TO TERMINAL BYPASSING FORMATTER
C
C
C    Method:  This subroutine compares the calling program's FMP error
C             code with the error codes listed in file FMPLST and will
C             display the associated error description on the terminal or
C             log device.
```

```
*
C   References:  File FMPLST
C
C
      SUBROUTINE FMPER(IERR,NAM,LU,MESS)
     *,Returns FMP error on FMP Call
      INTEGER IBUF(40),IDCB(144),NAM(3),NAME(3),SUBER(14),PGERR(15),
     *        IASCI(3),RIGHT,MESS(1)
      DATA NAME/2HFM,2HPL,2HST/, LDASH/026400B/,
     *PGERR/2HIE,2HRR,2H =,3*2H  ,2H I,2HN ,2HPR,2HOG,2HRA,2HM ,3*2H  /,
     *SUBER/2HSU,2HBR,2HOU,2HTI,2HNE,2H F,2HMP,2HER,2H  ,2HIE,2HR ,2H= ,
     *       2H  ,2H  /
C
C RETURN IF NO ERROR  (>0)
C
      IF(IERR .GE. 0)GO TO 90
      IF(LU .LT. 1)LU = 1
C
C OPEN FMP ERROR DESCRIPTION FILE
C
      CALL OPEN(IDCB,IER,NAME,3,0,12)
      IF(IER .LT. 0)GO TO 30
C
C GET ERROR DESCRIPTION RECORD
C
10    CALL READF(IDCB,IER,IBUF,40,LEN)
      IF(IER .LT. 0)GO TO 30
C
C CONVERT ASCII NUMBERS TO BINARY W/O USING FORMATTER
C RIGHT HALF
C
      IEC   =  IAND(IBUF(2),000377B) - 60B
C
C LEFT  HALF
C
      ISIGN =       IBUF(2)   / 256 - 60B
      IF(ISIGN .LT. 0)GO TO 20
      IEC   =  ISIGN   *  10  + IEC
C
C RIGHT HALF
C
      ISIGN =  IAND(IBUF(1),000377B) - 60B
      IF(ISIGN .LT. 0)GO TO 20
      IEC   =  ISIGN   * 100  + IEC
C
C ERROR CODE IS REALLY NEGATIVE
C
20    ISIGN = -IEC
C
C LOOK AT NEXT RECORD IF FMP ERROR DOES NOT MATCH ERROR NO.
C
      IF(IERR .NE. ISIGN)GO TO 10
C
C CONVERT FMP ERROR NUMBER TO ASCII
C
30    IPERR = -IERR
      CALL CHUMD(IPERR,IASCI)
C
C INSERT MINUS SIGN
C
```

```
      IASCI(2) = IOR(LDASH,IAND(000377B,IASCI(2)))
C
C LOAD DISPLAY BUFFER WITH ERROR NUMBER & PROGRAM NAME
C
      DO 40 I=1,3
        PGERR(I+ 3) = IASCI(I)
40      PGERR(I+12) = NAM  (I)
C
C DISPLAY FILE ERROR NO. & PROGRAM NAME
C
      CALL REIO(2,LU,PGERR    ,15)
C
C DETERMINE LENGTH OF MESSAGE BUFFER
C
      I = 1
      J = 0
50    LEFT = MESS(I) / 256
      IF(LEFT  .LT. 32  .OR.  LEFT  .GT. 126)GO TO 60
      J = J + 1
      RIGHT = IAND(377B,MESS(I))
      IF(RIGHT .LT. 32  .OR.  RIGHT .GT. 126)GO TO 60
      J = J + 1
      I = I + 1
      GO TO 50
60    IF(J .GT. 0)CALL REIO(2,LU,MESS,-J)
C
C BRANCH IF ERROR ON DESCRIPTION FILE ACCESS ALSO
C
      IF(IER .LT. 0)GO TO 70
C
C DISPLAY ERROR DESCRIPTION
C
      CALL REIO(2,LU,IBUF (4),LEN-3)
      GO TO 80
C
C DISPLAY ERROR IN ACCESS TO ERROR DESCRIPTION FILE
C
70    IPERR     = -IER
      CALL CHUND(IPERR,IASCI)
      IASCI( 2) = IOR(LDASH,IAND(000377B,IASCI(2)))
      SUBER(13) = IASCI(2)
      SUBER(14) = IASCI(3)
      CALL REIO(2,LU,SUBER,14)
C
C CLOSE ERROR DESCRIPTION FILE
C
80    CALL CLOSE(IDCB,IER)
90    RETURN
      END
      ENDS
```

END

DATE
FILMED

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DTIC